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PRESIDENTIAL ADDRESS OF

SIR CLEMENT DANIEL MAGGS HINDLEY, K.C.I.E., M.A.,

PRESIDENT, 1939–40.

For the great honour which has been conferred on me by my election as your President I offer my most heartfelt thanks. The position is one aspired to by every member of our profession, and while deeply sensible of the great privilege of serving The Institution afforded to me by your votes, I am even more aware of the heavy responsibilities which must be undertaken, heavier perhaps than those usually borne with such success and dignity by my predecessors.

The moment at which I take my place as your seventy-fifth President is one of the most critical in the history of our country and in the life of our Institution. With every effort that can be summoned we are fighting for our freedom—freedom of thought and conscience, and freedom to continue the great work of civilisation. All those things which make up life as we have known it are at stake—the state of peace throughout our commonwealth of nations, " Wherein ", as King George V said, " every man may eat his bread in peace without anyone to make him afraid ", the ideals with which we have been brought up from our earliest youth, our liberty, and our religion. Amongst these things there is that which must always be paramount to us as Engineers, the right to use our knowledge and experience to further the arts of peace and the progress of the human race. This right, which is inherent in the very foundations of our profession, we have jealously guarded since our forefathers established it and procured its expression in our Royal Charter, and we are now determined to fight for it until it is secured for all time.

Amongst all professions and callings which, in so great diversity, make up our national life, Engineers are as deeply concerned as any other citizens in fighting with all the resources at their command for the establishment of conditions in which they can work for the preservation and progress of mankind, rather than for mankind's destruction.

At a moment like this I need make no apology for having dispensed with the formalities of a Presidential Address of the usual type, and for having consigned what I had prepared to the waste-paper basket. I had intended to tell you something of the cultural history and development of our Institution, and to draw from that history some conception of the future shaping of our work. Instead I will give you the picture I have in my mind of the duties which have now to be taken up by The Institution as a corporate body and by its members as individuals.

In peace-time the work of The Institution tends to become stereotyped in certain obvious directions determined by the development of its organization through many years. With the routine of holding meetings for discussion, of examinations and elections, of setting up Committees for investigation and research, and of publishing the Journal, the essential functions of a body such as ours are apt to be obscured and overlaid by a species of ritual.

War, and the upheaval of our normal life which war brings to us, give us the incentive and the insistent need to hark back to the principles of our Charter, to examine our activities, and to bring them into line with the necessities that face us.

We were enjoined by our Founders to devote ourselves to the advancement of mechanical science and "the art of directing the great sources of power in nature for the use and convenience of man." Out of this somewhat simple formula there has arisen the organization as we know it to-day, with its Roll of over 12,000 engineers bound together by a common allegiance to self-imposed standards, its manifold activities in furthering advances in engineering science, and its widespread influence amongst engineers throughout the world.

In many directions these activities must be curtailed by the exigencies of war conditions. For the present it will not be possible to hold regular meetings for the discussion of Papers. Certain time-honoured and traditional ceremonials, such as the Annual Dinner and the Conversazione, must be omitted, and the pre-occupation of so many members with their national duties, either military or civil, will reduce the volume of individual effort available for the direct prosecution of the objects of The Institution. Nevertheless, the need for carrying on the vital functions of The Institution as the centre of the profession, and the organization for ensuring continuity in standards, and of affording its members such support and stimulus as will enable them to increase and enlarge their knowledge, is perhaps more insistent in war than in peace.

I believe The Institution's most important functions to be, firstly the maintenance of high standards, educational and practical, for the admission of new members, secondly the encouragement of members to contribute their experience and knowledge to the common stock of the profession, and thirdly the prosecution of research and investigation.

There are many activities ancillary to these main functions. For

instance, the maintenance of high standards for admission implies not only devising the necessary tests and providing the means of applying them in the form of The Institution's examinations. It also involves taking an active interest in the education of young men who are aiming at entering the profession, and exercising some measure of supervision and control over their training. As an extension of this activity The Institution requires reliable evidence of experience before approving transfers to the class of Member.

We have to see how this function can be adequately carried out in war-time. We shall maintain the continuity of our examinations, the scrutiny of proposals for admission, and the holding of the necessary meetings for election; but we shall have to take an even closer interest than we have done in the past in the means open to our young men to obtain the necessary education and training. It is greatly regretted that we have had to interrupt the plans for holding a Conference on Engineering Education and Training early next year, for the discussions that had been planned would have been of great value in the changed circumstances in which we now find ourselves. If opportunity occurs I hope it may be possible for The Institution to lend its influence in the adjustment of curricula to war conditions. In these adjustments I hope it may be possible, for instance, for educational authorities, such as the Universities and Colleges on the one hand and the Schools on the other hand, to arrange for technical studies to be pushed on as far as is possible in the years before military service has to be given. There are also to be considered the cases of young men training for the profession who do not go to the University but who carry out their training as pupils, apprentices, and assistants under agreement, and who study and sit for the Institution examination.

The Institution will continue to exert all the influence it can command to ensure that those who are already in process of receiving technical education may be enabled to continue their training in Technical Units of the Forces, and to be employed where their engineering grounding will be of the greatest national service.

It would be lamentable if the essential means of equipping the rising generation with engineering knowledge and experience should be interrupted by military necessity. Not only is this younger generation of potential engineers a vital necessity for the military effort which has to be made and which may be of long duration, but it is even more a necessity for the period of reconstruction which will follow when peace is secured. At that time more than ever will Great Britain need a well-equipped body of trained engineers to secure its industrial recovery and to make good the inevitable wastage of its material resources. If The Institution can use its influence to secure this continuity in the process of "making new engineers" it will have succeeded in performing a service of great national value.

The second of the main functions of The Institution to which I have

referred is the encouragement of members to contribute their experience and knowledge to the common stock of the profession. This was perhaps the earliest activity of The Institution, and at first almost the only one. There has been little break in the steady succession of meetings of members for discussion of Papers during the 121 years of our history. Now, however, that The Institution finds itself, so to speak, in the firing line, it has been necessary to break this continuity. To some extent we can fill the gap by continuing the publication of the Journal and by inviting written discussion on the Papers published. It is probable that with the present suspension of many large public works, there may be for some of the older members opportunities for recording accounts of recently-completed works which in normal times they would have been unable to undertake. Also, in the greatly stimulated field of constructional work for military or defence purposes new problems are constantly arising and being solved, new methods have to be evolved, and work has to be carried out under conditions of which the implications are largely unknown. As an example may be instanced the great and varied scope of the problem of providing protection for the civilian population against bombing from the air. The work that has been done in investigation, design, and construction during the past 2 years in this direction, to which so many members of The Institution have made, and are making, notable contributions, has, in the view of some, almost added a new branch to the profession. In the opinion of others, to which most of us will incline, the exercise of this new power acquired by man along with his conquest of the air, has introduced a factor into all branches of our work, which, from the magnitude of its effects, may almost be said to have taken its place amongst the "great sources of power in nature", control of which is the object of our science.

Whatever may be the result of the present conflict in putting an end to the activities of those who have made aggression and terrorism the principal aim of national policy, I can see little hope within any measurable period of time of obtaining for the human race in any part of the world permanent immunity from attack from the air by evilly-disposed persons or organizations. The possibility of such attack must introduce into all our methods of design and construction of buildings and public works the additional strength and protective devices necessary to enable men to carry on their avocations in reasonable security. With the knowledge that has been gained already in the present experimental period, supplemented by that which will emerge from any ordeal through which we may have to pass, I see no inherent difficulty, either of design or of cost, in providing such reasonable protection for any organized community.

We shall look forward to publishing in the Journal whatever material may be made available in regard to this aspect of constructional work, so that our members may have the benefit of progress in the knowledge of the subject. We shall also endeavour to utilize the Journal for keeping

members informed of progress on other branches of work and encouraging discussion.

The Local Associations, both in Great Britain and overseas, are being asked to maintain their organizations and to take any opportunity that may occur of continuing amongst their members an active interest in the affairs of The Institution. In some cases it may be possible for them to arrange meetings, and they may be assured that The Institution will support their efforts to keep members in touch with one another and with headquarters.

I come now to the third main function, namely, that of research and investigation. In so far as it is possible for the various scientific organizations which have undertaken research for The Institution to continue their work, The Institution will maintain its financial support. Some of these researches have already had to be suspended owing to the exigencies of National Service, but others may be carried on to a conclusion. For the present it may not be possible to commence any new work of this kind, but whenever problems arise which seem suitable for investigation in the circumstances obtaining, we shall not hesitate to seek the necessary means of investigation. The Research Committee will remain in being, and will be called together when necessary to deal with problems which may be suggested to us. As in the past, we shall hold our resources in this respect available for any work which the Government may consider can best be carried out by our members.

These are the directions in which it appears to me that The Institution can best pursue its activities in war-time.

As regards individual members, their fundamental duties are so obvious as hardly to need re-stating. As citizens they will cheerfully and resolutely obey any call that may come to them in the national interest. As engineers they will give their accumulated knowledge and experience to whatever efforts may be demanded of them, and in whatever sphere they may be called upon to serve. While concentrating all their specialized capacity on the furtherance of the national effort, they must keep always before them the work of reconstruction and advance in the standards of civilized life throughout the world that will have to be undertaken when the time comes for the human race to be freed from the recurring menace of gangster nationalism. If we had not that hope of an even larger and more spacious freedom than we have hitherto known, the outlook would be dark indeed. We may, however, be sure that when we have passed through the present ordeals and have achieved the victory for freedom for which we are now fighting, there will be unimagined opportunities for applying for the benefit of the human race those advances in science which are even now taking place under the stimulus of war. It is necessary for all engineers to continue to keep abreast of developments in engineering science and practice, and so to fit themselves for this great work of the future.

I feel the greatest confidence that members of The Institution, and all other engineers, will acquit themselves in a manner worthy of our great traditions, and that, so far from allowing hardships and trials to master their spirit, they will be able to say with one of our famous Generals, "I thank God that I have been permitted to live in the midst of such tremendous events."

BRITISH-AMERICAN ENGINEERING CONGRESS, 1939

The following Paper, dealing with conditions in Great Britain, was to have been presented at the British-American Engineering Congress at New York in September, 1939, and was therefore primarily prepared for reading before American engineers.

"City-Planning, with Special Reference to the Operation of the Restriction of Ribbon Development Act, 1935."

By Herbert John Baptista Manzoni, M. Inst. C.E.

TABLE OF CONTENTS.

Introduction.

As a result of the industrial revolution in the last century, the population of the British Isles became herded together into rapidly-growing towns. Industries settled in suitable areas and attracted one another, as well as the people to whom they offered employment and the many benefits of trade. These centres of population had one thing in common. They were all composed of a conglomeration of badly-crowded houses, ugly factories, and narrow streets. Amenities of any kind were never thought of, save, perhaps, churches and licensed houses. Almost the only pre-occupation was with the manufacture of one thing or another; so long as people had somewhere to sleep they were considered to be satisfied.

Such conditions continued to exist in most of the older towns, and widespread dissatisfaction throughout the country made some attempts at amelioration necessary. The Housing, Town Planning, &c. Act of 1909 first introduced planning, which has since been broadened and extended by later Acts, and by detailed study of the many problems involved, until now some two-thirds of the area of England and Wales is covered by planning schemes either approved or in process of preparation.

Development Prior to the Introduction of Planning Powers.

Most big cities in the British Isles developed long before town-planning practice commenced, and when planned development started it was in the nature of extensions to what already existed. No attempt was made to improve the old cities, which could only be changed over a long period extending into several generations. The comprehensive planning of areas as complete units could not be undertaken, and, indeed, earlier legislation was limited to land not yet developed. Handicapped as it was, early planning could not be successful, and it continued many unsatisfactory features. In the planning of lines of communications, for instance, although newly-developed areas are provided with well-designed communications, those communications are connected to existing main roads, the lines of which have never been planned and are totally unsuited to modern needs. The same handicaps apply to zoning, which all too frequently can only be related to existing conditions. Land-values prevent the proper siting of features such as open spaces, and almost invariably aerodromes—the most modern need of communities—have to be constructed many miles from the centres they are provided to serve.

The Planning of Built-Up Areas.

The Town and Country Planning Act of 1932 has, however, provided powers for the planning of built-up areas, and problems of immense difficulty have been raised in this respect. Such planning must inevitably be for the distant future, for without unlimited money little can be done within the present generation, and to conceive a plan to meet such conditions as are likely to exist in, say, 50 years, is indeed a difficult problem. Nevertheless, some plan for rebuilding the heart of each of the large cities must be devised to which gradual re-development can conform, and to which the planning of concentric areas can be related.

The planning of built-up areas has received a further stimulus with the Housing Act of 1936, which includes provision for re-development as well as for slum-clearance.

It is easy to visualize the problems created by the removal of big areas of insanitary houses; the proper use of the ground so cleared can only be decided in relation to a comprehensive plan for a large district.

The Effect upon Industry.

Perhaps the greatest factor requiring consideration in such replanning is the industrial and commercial enterprise established in the area. Dislocation of industry and commerce must be avoided if possible, because they provide the livelihood of the population around them, even though their presence has been the chief cause in the growth of such dismal towns. There are many ways in which trade can be adversely affected: bad

communications for the transport of raw materials to the factory and of finished articles to the market; the transference of the homes of the work-people far from the place of work; the lack of provision for the normal expansion of business premises; and the diversion of traffic and population from main shopping areas. All these factors have their effect on the established industries of an area.

Space-Economy.

The primary evil of the older built-up portions of the towns is that of space-congestion. Open spaces are almost non-existent, roads are narrow, and houses much too overcrowded. The problem of replanning these areas is, therefore, also one of finding extra space for healthy conditions of living and working. Economy in space can be effected in two principal ways; namely, by vertical building, and by the replanning of the highway system. The judicious use of both of these methods of securing space-economy in the execution of the duties imposed upon local authorities by housing and town-planning legislation, provides a means for rectifying many evils in the case of the larger towns and cities.

Vertical Building.

In many industrial processes vertical building has been recognised as advantageous, and its further adoption may help in conserving space. The density of dwelling-houses is often as high as seventy and eighty to the acre, and where there are only about forty to the acre they are far too crowded according to modern standards, being without garden space or any amenity other than paved courts or yards. Further, replanning is often rendered more difficult by popular likes and dislikes in the form of accommodation.

Tenement dwellings limited to four or five storeys in height can be built at densities of between forty and fifty to the acre, and take up not more than 18 per cent. of the available space, thus leaving plenty of space available for such amenities as gardens and playgrounds.

Replanning of the Highway System.

The replanning of a highway system can result in considerable saving of space, even after the provision of properly-planned roads up to modern standards and widths. A recently-drawn plan of a re-development area in the City of Birmingham, extending for nearly 300 acres, resulted in a surplus of as much as 19 acres after proper provision had been made for both industrial and residential needs as well as for wide well-planned roads.

Slum-Clearance.

Housing activity in the period of 10 to 15 years immediately following the war of 1914–1918 did much to solve the great housing shortage that

had developed partly through the cessation of building during those 4 years and partly in pre-war years. This was effected largely by the development of suburban areas into extensive estates suitably planned with houses of modern design, not exceeding twelve to the acre, and good roads; zoning had been considered in many cases, with due provision for industrial and commercial areas, and adequate open space for parks and recreation was always reserved. The result, however, was not entirely satisfactory; the estates lacked character, and they presented a monotony, not exactly of appearance but of type. There was an absence of that balance which an area acquires by developing slowly instead of being forced into existence by pressure of needs. The final effect of all this building, both public and private, has been to extend the suburban areas of the larger cities many miles into what was open country and green fields, reducing to that extent the amenities of the towns as a whole.

Re-development and slum-clearance, however, should result in the replacement of homes near to the areas to be cleared, and to do this properly a complete planning scheme must be prepared for the central districts of a town, with a proper segregation of the various zones, provided with adequate communications, and having conditions generally up to modern standards.

The Growth of Urban Areas.

This modern growth of monotonous suburbs has caused a reaction against their further development. London, for example, occupies several hundred square miles of built-up area, and, it has been estimated, is likely to attract within a not lengthy period one-half of the population of England, whilst Birmingham itself covers 80 square miles of ground, without including the adjacent "Black Country" area of approximately similar size. The various towns of Lancashire provide a further example of this development, for which the word "conurbation" has lately been coined.

Economic conditions have accelerated this development. The population provides both a market and a pool of labour. Many industries are complementary to one another, and need no longer be sited as near to their raw materials as at one time was necessary. Population increases trade, and trade increases population.

The realization that these conditions are far from ideal is, however, growing everywhere, and has been strengthened by the unhappy necessity of considering methods of defence against hostile aerial attack.

The Preservation of Rural Areas.

The preservation of rural land adjoining large cities has now become of vital importance. Such land is invariably outside the boundaries of the

city, and, moreover, development of it is very often encouraged by the rural authorities to improve their rate-return, whilst the proximity of expensive services, such as drainage, water, and power, as well as the presence of a convenient market and a supply of labour, are further inducements. Thus a conflict of interests arises between adjoining authorities, and urban areas tend to extend far beyond their administrative boundaries.

The Control of Urban Expansion.

The problem of how to control this urban expansion has given rise to many suggested solutions. One is an embargo on all building within a fixed distance from existing boundaries, thus providing a green belt from 10 to 20 miles in width; another is a combination of this method with the development of satellite towns; whilst a third is the use of a system of radial development. The use of any one of these methods would need to depend on circumstances, but the first is likely to be so drastic as to be impracticable.

By some such methods cities must be prevented from extending to unwieldy proportions, without limiting them so much as to prevent that balanced development which helps to smooth out the curve of industrial development from prosperity to depression, a fluctuation which marks those districts more dependent upon individual basic industries.

The Effect of an Embargo on Building.

The result of a rigid embargo on building outside a defined radius of a city would result in an increase of density in the urban area through natural expansion, and a point would be reached when a decline in the prosperity of the district would follow a transference of trades to where freedom of development could be allowed. Such an event would create evils more severe than those now existing. Control must be elastic enough to allow of proper co-ordinated development, and this inherent fault of rigid control is also present in the use of the method of satellite towns.

The Development of Satellite Towns.

The development of satellite towns would have to be accompanied by some provision for their limitation of size, as otherwise they would become rival centres to the parent city and would create again the same problems of control. Limitation of size, however, would result in the creation of many such areas because of the rapid growth of population, and the multiplication of small satellite towns could hardly be a desirable feature.

Spur Development.

It would seem that a system of spur development, defining directions and limits within which urbanization would be allowed, would provide a solution to the problem which would not suffer from these rather serious defects. The result would be the creation of spurs linked like spokes to the central hub and providing for open country between as a general amenity and for agricultural purposes. Provided that the width of these spurs was limited to approximately 2 miles, the open land need never be more than 1 mile from any of the newly developed districts, and yet proper development would not be restricted but would only be controlled in direction. Contact between the various areas would be maintained, proper amenities would be preserved, and the products of agriculture would have a market ready to hand. Road communication would be made easier and could lead directly from centre to centre without restriction. Ring roads could be built more easily, since they would be largely across country without development alongside. Railways could run along the spurs, supplying premises on the route, and airports could be sited near to the areas they were designed to serve instead of many miles away, with the consequent loss of much of the time saved by extra speed in travel.

The Road System of the British Isles.

The whole subject of road communication has become so vital during recent years, due to the phenomenal increase of motor traffic in the British Isles, that a great amount of thought has been given to the subject, and a considerable amount of progress has been made in the general improvement of existing roads and in the building of new ones.

It must be realized that practically the whole of the main-road system of the British Isles is an unplanned system, inasmuch as there has been no major scheme for the making of national roads, connecting one town with another or connecting any town with the coast, since the time when the Romans laid out a rudimentary system 1800 years ago. At the same time England has probably a denser system of highways than most countries, and although the great majority of the highways are a development of field tracks and private roads, they have been continuously improved until the communication in any direction and between any two points is almost as direct as if the roads had been originally planned for that particular purpose. As an example, the distance between London and Liverpool is approximately 200 miles, but it is possible to accomplish the journey by at least four good main roads with less than 10 per cent. variation in distance, and the same applies in almost any part of the country.

During recent years the construction has been freely discussed of a separate system of purely motor-roads between main centres of

population as an alternative to the improvement of existing routes, and a recent Act of Parliament, known as the Trunk Roads Act, whereby the Government for the first time took over the complete control of the trunk roads of the country (that is to say, the main communicating roads, aggregating about 4,500 miles in all), was an indication of the necessity of concerted policy.

The Government were faced immediately with this particular problem, and up to the present time they have apparently decided that a system of improvement of existing highways, with the construction of by-passes around important towns, is to be their line of action rather than the building of a completely new system of highways across open country.

The necessity of by-passes is very apparent, because the existing roads lead directly into the centre of every town and village, and it is just at these points where they are heavily built up on each side and where their width is confined to the standards which were adequate 100 years ago.

The Restriction of Ribbon Development Act, 1935.

About 12 months before the taking over of the trunk roads by the Government, an Act was passed called the Restriction of Ribbon Development Act; the origin of this Act seems to have been the wish by certain private societies to check the continuous building of properties alongside the main roads of the country, which was spoiling the amenities of the highways.

Many of the roads in Great Britain are very old and very beautiful, and they form the viewpoint for the thousands of motorists who seek their recreation by driving into the country as a relief from town atmosphere. This tendency to get out of the towns, which is fostered by the popularity of the motor-car, is, in fact, one of the chief causes of the recent growth of ribbon development. Commencing with the establishment of petrol stations, wayside garages, and cafés, and continuing with the building of houses, there are many situations on the main roads, at quite considerable distances from the towns, where building has taken place in a continuous line along each side of the highway without any attempt to build residential estates at any depth, and the consequence is, of course, that the open country is completely blotted out from the travellers' view. In a country such as England, where the towns are comparatively close together, this state of affairs is very obvious and very harmful, whereas it would probably be unnoticed in a larger country such as the United States of America, in some parts of which the proportion of open land is very much greater as compared with the built-up areas. In the course of its preparation, however, this Act was made the opportunity to introduce several measures of safety and urban amenity.

Restriction of Access.

The prevention of ribbon-building is sought to be achieved by the restriction of access to the main road, and the Act lays it down that on certain roads—that is to say, those which are classified as important traffic routes—no building shall take place without the consent of the responsible Authority within a fixed distance from the centre of the road, and other clauses give the Authority power to say where and how vehicular access on to the road shall be allowed.

The contemplated widths range up to 440 feet, and the restriction of access is intended to be applied to the passage of pedestrians as well as to the movement of vehicles.

The principles underlying these restrictions are, firstly, the obvious one that the setting back of buildings will allow sufficient space for the adequate widening of the roadways to provide for the passage of a large increase of traffic, and secondly, the elimination of a great proportion of the danger-spots caused by incoming traffic from side roads and individual premises; in these respects the provisions appear to be purely safety provisions affecting road traffic. A further intention of the Act, however, is that the immediate economic advantage of building property fronting a road already constructed shall be denied to the owner of the frontage land. In developing a residential estate or, in fact, any type of estate, a landowner is faced not only with the cost of the erection of buildings but also with the cost of constructing roads to give access to those buildings, and it is very natural that owners of land fronting on to existing highways find that they are enabled to eliminate the latter cost, and consequently to make a very profitable use of their property. It follows, therefore, that to take away, by restriction of access, the benefit of an existing highway, places the necessity upon an owner of land to provide new roads to serve the whole of the properties which he may erect, and it is hoped that this will result in the building of residential estates of some depth from the main highways rather than in the form of ribbon estates alongside them.

It is, of course, impracticable entirely to eliminate all access to a main road, and the interpretation of the Act, in so far as it has been in operation during the past 4 years, has been on the lines of restricting vehicular access to incoming highways to points spaced at distances of something approaching 400 yards apart and usually accompanied by the construction of a properly-designed roundabout, where the speed of all traffic will be naturally restricted.

It is unusual in the British Isles for people to own so much land that they could adequately develop estates having road access to a main highway at such distances, many landowners being in possession only of a comparatively small frontage and wishing to make the best use of it. In consequence the practice of constructing service roads alongside the main highways has become very common, and it has been necessary to allow these service roads to communicate with the main highway at each

boundary of the owner's property, with the intention that as development becomes continuous the service roads shall be linked up and shall have access only at the properly designed points (*Figs. 1*, pp. 16–17).

Up to the present time there has been no obvious inclination on the part of speculative builders to comply with the intention of the Act by building estates of depth rather than of length, and the result in many cases is a continuation of ribbon development but with the advantage of a greater width of reservation between the properties on each side of the highway, and with the additional advantage of a certain amount of restriction of the points where traffic may join the main carriageways. The construction of service roads, which in practice are usually about 14 to 18 feet wide, alongside the main roads, is becoming a feature of areas immediately adjoining the larger towns, because the rate of house-building in England during the past 10 years has been very great, and in fact is continuing with very little abatement at the present time.

It will be seen, therefore, that those provisions of the Act which are designed to ensure greater safety and better provision for increase of traffic are in fact being operated quite satisfactorily, but that the amenity provisions which should have the effect of preventing continuous ribbon building unfortunately are not so effective.

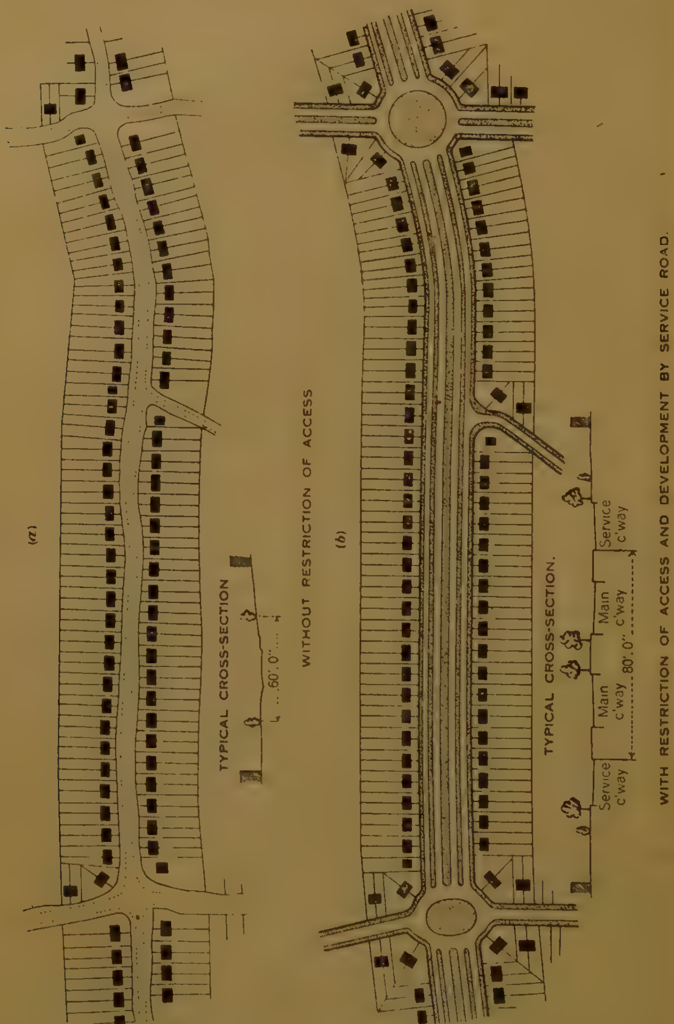
It is, of course, possible to prevent the continuous spoliation of the roads by other means; for example, town-planning and the reservation of land as open space or for agricultural use would have a similar effect in preserving the countryside in an unbuilt-upon condition, but although about two-thirds of the country is the subject of town-planning schemes—either in draft or in full effect—it is only recently that the necessity of reserving large areas of land in its present agricultural use is becoming a feature of modern tendency. Further, since town-planning restrictions of this nature carry with them the possibility of the payment of compensation to the owners of the land, it is doubtful whether these restrictions will be brought right up to the boundaries of the main trunk highways, because it is just along these highways that the most expensive potential building land exists, served as it is with easy road access and, in many cases—especially near towns—with the subsidiary services of drainage, gas, water, electricity, and telephones.

Application to Built-Up Areas.

The actual machinery of the Restriction of Ribbon Development Act is somewhat complicated and its legal interpretation is still a matter for controversy, but perhaps one of the most difficult points to decide in connexion with it is the situation in which the Act should be applied. It is quite obvious that in open country, away from built-up areas, its operation is straightforward and simple, whilst the compensation for which the Act provides is unlikely to be so great as to prevent its use, but in the neighbourhood of large towns and cities its use is very problematical, because

amongst its many provisions is one which allows the landowner to claim compensation for its effect upon the value of his land in the restriction of access and in the loss of space. The compensation may easily amount t

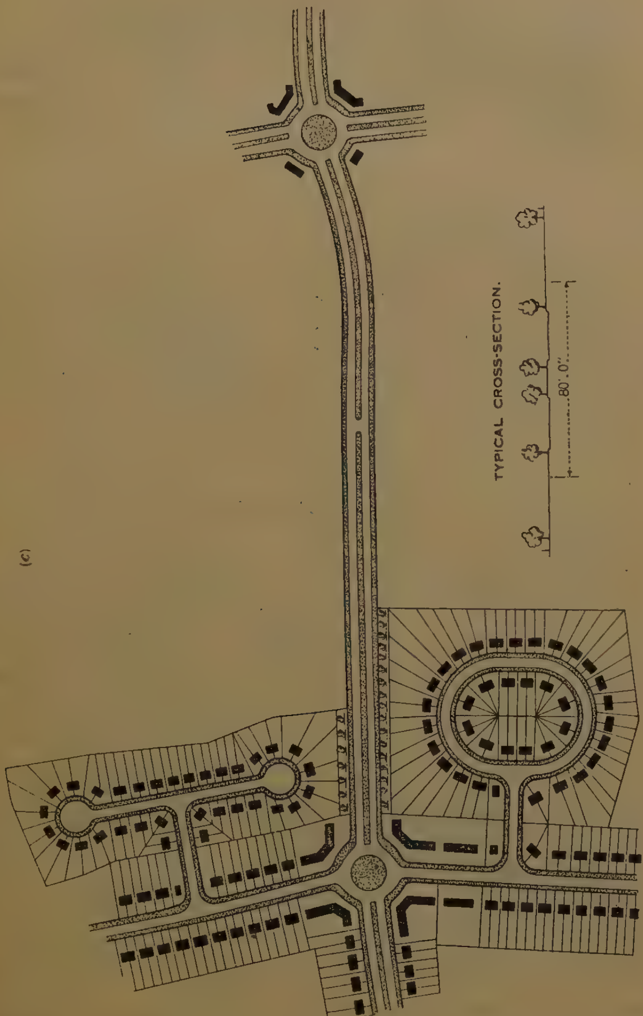
Figs. 1.



to the whole cost of the purchase of the additional width and the construction of the service carriageway, so that the whole expense of the improvement would fall upon the Highway Authority.

The most difficult case of all, however, is the application of the provisions of the Act within the boundaries of a built-up town. It is quite

obvious that the effect of restriction of access, quite apart from the drastic setting-back of buildings in a busy commercial area, would be very serious ; so much so, in fact, that it may entirely disturb the trade of the district



WITH RESTRICTION OF ACCESS AND GROUPED DEVELOPMENT.

RESTRICTION OF RIBBON DEVELOPMENT: DIAGRAMS SHOWING TYPICAL DEVELOPMENT.

and may so curtail the sites available for building or rebuilding as to render comparatively useless a prosperous industrial neighbourhood. For this reason it is held by many that the Act should not have applied to towns and cities, and in fact a definite exclusion was made in the case of the administrative County of London, but there were no other exceptions

made at the time of the passing of the Act, and the problem is being faced in many instances in large towns like Birmingham, Liverpool, and Manchester. In these towns it has been found quite impossible to arrange for the application of the building setback to anything like the extent applicable in open country, but the restriction-of-access clause can be applied in the case of the rebuilding of large factories or business premises where power is given to the Local Authority to specify the number of gateways and the positions from which vehicular traffic may issue on to the main road.

Other Clauses of the Act.

There are other interesting clauses in the Act which give a lead to Local Authorities in the matter of the provision of parking places, but these are purely permissive powers enabling a Local Authority to purchase land or buildings compulsorily, and to use such land and money from the local rates for providing garages and car parks within their area. By far the most interesting clauses are those dealing with the restriction of access and the standardization of road widths.

Modern Road Design.

Dual Carriageways.

The operation of the Act and the recent necessity for making extra provision for vehicular traffic in Great Britain has resulted in a very radical change in the design of roads. Some years prior to 1914 there had been constructed in certain parts of the country short lengths of dual-carriageway road, and since 1918 these roads have been extended on the outskirts of certain of the larger cities, notably Liverpool and Birmingham, in the latter of which no less than 26 miles of this form of highway have been built to date.

These examples have formed a pattern for many of the county roads, and it is now possible in travelling about the country to find long stretches of dual-carriageway road which give a very great amount of additional safety for fast traffic.

Cycle-Tracks.

A further development in road design is the provision of cycle-tracks, incorporated as part of the footpath-space, and despite the opposition of the official cycling bodies in the country, the use of specially constructed cycle-tracks is extending very rapidly; it is interesting to note that, whilst they are boycotted by members of certain of the organized cycling bodies, they are used to a very large extent by the much bigger body of individual cyclists who prefer to follow their own wishes rather than to

Fig. 2.

MODERNIZATION OF EXISTING ROAD IN THE CITY OF BIRMINGHAM.

conform to the opinion of organized clubs. In a recent census on a certain stretch of road constructed with cycle-tracks the percentage of cyclists using the tracks was as high as 84·5.

The majority of these new roads have widths between boundaries of well over 100 feet. The main carriageway is normally constructed with widths of from 20 to 24 feet, the central reservation of about 20 feet usually being turfed and planted with trees and shrubs, whilst the cycle-tracks have a width of 9 feet, and the footpaths are 6 feet or more across.

Service Roads.

The construction of service roads, however, as a result of the operation of the Restriction of Ribbon Development Act, adds in some cases a further 40 or 50 feet to the total width of the road, so that highways having a total effective width of about 150 feet are beginning to appear in various parts of the country. Incorporated in their design are such features as a fence separating the service roads from the main carriageways, and specially-constructed pedestrian-crossing places by way of bridges or subways.

Development of Modern Roads.

It will be appreciated that roads of this nature are likely to be constructed in stages, because the majority of them are built in open country as improvements are necessary to the existing highways, the first stage being the construction of a dual-carriageway road with cycle-tracks and footpaths, and the second stage being the construction of service roads alongside as the land is developed for building purposes.

It is doubtful whether there is any necessity to have both service roads and cycle-tracks, because the service roads would undoubtedly be subject to a speed restriction which would probably give sufficient safety for cyclists, and if the service roads were continuous the cyclists would never need to ride on to the fast traffic carriageways.

In a recently-designed road in the City of Birmingham an attempt has been made to incorporate most of these features over a length of 2½ miles, and an illustration of the construction is shown in *Fig. 2.* This road has been bordered with property throughout its entire length during the past 10 years, and prior to that date the width between fences had been fixed at 110 feet in order to provide for an ordinary dual-carriageway road. It was consequently impossible to get any additional width, but the provision of service carriageways has been achieved within these boundaries. The service carriageways have a width of 18 feet, and the pedestrian footways are 7 feet wide. They communicate with the main-traffic carriageways only at properly designed roundabouts where incoming roads also adjoin, and within these communicating points there are stretches of about ½ mile where there is no access whatever to the main carriageways from either side. Fences are provided to restrain

pedestrians from crossing except at points ¼ mile apart, where subways are provided underneath the carriageways. There is not sufficient space to incorporate separate cycle-tracks, but here the principle of cyclists using the service roads will operate. This highway embodies within the limits of its prescribed width the principle of segregation of traffic, which is considered to be a necessity if the number of road accidents is to be reduced.

Paper No. 5213.

"Application of Experimental Methods to the Design of Clarifiers for Waterworks."

By Robert Walton and Thomas Dow Key, M. Inst. C.E.

(Ordered by the Council to be published with written discussion.)[1]

TABLE OF CONTENTS.

Introduction.

Since early times the City of Alexandria has depended for its water supply upon the Mahmoudieh canal, a canal which branches off from the river Nile at a point well below Cairo and which terminates at the sea locks of Alexandria. It is approximately 60 miles long, and is the most north-westerly of the many branches of the delta through which the waters of the Nile are discharged into the Mediterranean.

This water, when it reaches Alexandria, in view of the variability of its quality and the treatment it requires, presents an ever-changing problem to those whose work it is to ensure the supply of pure and wholesome water to the 680,000 inhabitants of the city. The degree and rapidity of its change of quality and amount of suspended matter demand an alert supervision at all times, and, as a result, it has been necessary to develop a system of control whereby changes in the raw water can be detected quickly, so that the process of treatment can be varied accordingly. The variations are such that they call for immediate and drastic changes in the dose of coagulant, and sometimes the improvization of especially suitable methods of treatment. During 1 or 2 hours, suspended matter has been known to increase from 100 to 800 parts per million, thus necessitating the use of aluminium-sulphate doses of 6 grains

[1] Correspondence on this Paper can be accepted until the 15th March, 1940, and will be published in the Institution Journal for October, 1940.—Sec. Inst. C.E.

per gallon or more, together with, on occasion, supplementary chemical treatment.

At Cairo, the Nile water sometimes contains suspended matter as dense as 5000 parts per million, the greater portion of which is non-colloidal and settles out on the bed of the Mahmoudieh before reaching Alexandria. The colloidal remainder, however, consists of very finely-divided silicious silt which can only be removed by chemical coagulatory methods. By "non-colloidal" suspended matter is meant those particles which respond to gravitational forces and obey Stoke's law. The truly colloidal particles, on the other hand, usually have diameters of less than 0·001 millimetre and carry electrical charges of similar polarity, the mutual repulsive energy from which is so much in excess of the influence of the force due to gravity that any tendency towards auto-sedimentation is prevented.

It should be pointed out that the task of water purification at Alexandria differs from, and is in some respects more difficult than, that at Cairo, for between the two cities there are many towns and villages, from each of which an appreciable quantity of sewage and proteinic manurial matter is discharged into the canal. Moreover, the canal is also part of the main highway from Upper Egypt to the seaboard along which, during the cotton seasons, there passes a closely packed stream of transport barges laden with a large part of Egypt's export cotton. These craft and their crews constitute an additional source of contamination.

The ultimate result, at Alexandria, of this cumulative pollution of an already turbid water with organic material, is to convert the original colloidal suspension of the Nile water from simple, easily-coagulable suspensoids into the lesser known, but more resistant, "protected colloids." The acquired "protection" is manifested by the greatly increased difficulty encountered when attempts are made to bring about such a degree of clarification that the water will be in a fit state for filtration after sedimentation. Colloidal protection is well known to chemists and represents a type of inhibitory action, or strong impediment, to flocculation by coagulants of the pre-existent, normal colloids. The presence of a "protected colloid" changes simple coagulation into what is almost a double-stage process, inasmuch as there is an induction period, when the bulk of the added chemical is being absorbed in breaking down the protection, followed by simple coagulation of the original normal colloid. A "protected colloid" demands the use of a larger dose of coagulant for its precipitation than does a normal colloid of the same concentration, the difference being absorbed in the destruction of the protection.

The changes involved, when a colloidal water is clarified with the aid of an electrolyte, are understood, and, ignoring side-reactions, may be briefly described as follows:—if a solution of aluminium sulphate is added to the water to be clarified, the calcium carbonate present in the water combines with the aluminium sulphate to form calcium sulphate, carbon dioxide, and insoluble gelatinous aluminium hydroxide; simul-

taneously, the electrical charges on the particles are neutralized and these suspended solids are caught up in the aluminium hydroxide to form hypobaric flocculi.

Considered from a physico-chemical point of view, the treatment of a colloidal water such as that from the Nile should, if the dose of coagulant is correct, proceed to completion within a few minutes of addition of the precipitant. The subsequent problems of endowing the particles with the maximum density and size to ensure rapid settlement devolves more on the mechanical treatment of the floc, in relation to the liquid in which it is suspended, rather than on chemical considerations. It is no longer a question of overcoming the inter-repellent electric charges on the isolated

TABLE I.

	Pre-flood: Jan.–July.	Flood: Aug.–Oct.	Post-flood: Nov.–Dec.	Mean.
Temperature: °C.	21·5	27·1	19·1	22·5
Clarity: centimetres	7·9	2·6	5·8	6·2
*p*H-value	8·0	7·8	7·9	7·9
Electrical conductivity at 20° C.: ohms per centimetre cube	343	313	255	320
Chlorides, as Cl: parts per million	20·7	25·7	16·0	21·0
Free ammonia: parts per million	0·035	0·003	0·019	0·025
Albuminoid ammonia: parts per million	0·278	0·645	0·322	0·377
Oxygen absorbed in 3 hours at 37° C.: parts per million	3·120	5·595	3·520	3·806
Suspended matter: parts per million	190·8	576·9	166·8	283·3
Aluminium-sulphate dose (1921–1930): parts per million	29·0	52·4	32·9	35·5
Bacteria on Agar after 24 hours at 37° C.: number per cubic centimetre	4,520	10,300	5,030	6,050
Bacillus coli: number per cubic centimetre	250	830	135	380

particles, but of arriving at an arrangement whereby the spongy electrically-neutral flocculi can be brought into contact with each other under conditions such that they will tend to be rolled on to each other, thereby increasing in size and density. These flocculi, if conditions are favourable, quickly sink to the floor of the containing vessel and form sludge. Any light flocculi which may be carried through the settling chamber are then easily removed by filtration through fine sand. The operation of rolling the particles on to each other is delicate, for if it is carried out by too violent means, the ultimate result will be to disintegrate the freshly formed agglomerates into a fine buoyant suspension.

Table I, which has been compiled from bi-daily examinations carried out in the laboratories of the Alexandria Water Company Limited, gives a

fairly typical picture of the manner in which the water varies throughout the year. It should be mentioned that the Nile is in flood during the months of August, September, and October, and that it is at this time that the greatest difficulty is experienced in securing satisfactory clarification.

During the last decade, the investigation of colloids of every description has been a subject of close study by chemists and physicists in all parts of the world, and a vast literature has continued to grow around this subject until it has finally developed into a strikingly progressive and specialized branch of physical chemistry. It is strange, nevertheless, that the subject of large-scale water purification—one of the oldest of colloidal chemical problems—has been neglected where the best method of aiding rapid flocculation, by the use of suitably-designed settling tanks, has been in question.

In the main, the design of those sedimentation tanks which have been intended to reproduce laboratory flocculation and subsidence tests has been left very much in the hands of draughtsmen who have had little more to guide them than certain empirical information and reference to tanks previously constructed, the results of the operation of which it has only been possible to obtain in general terms.

Usually, in a waterworks, the art of successful clarification depends upon the ability of the technician in control. It is his responsibility to arrange chemical treatment and the subsequent method of mixing and sedimentation so that the products of the reaction (namely, silt particles caught up in matrices of gelatinous, insoluble aluminium hydroxide) will agglomerate into well-formed dense non-buoyant flocculi of the largest possible individual size and weight. The attainment of such conditions will ensure rapid precipitation of the solids. Adequate coagulant dosing followed by the wrong type of stirring, will result in the disintegration of the flocculi, and the bulk of the solids will be floated through the sedimentation basins on to the filters, with consequent extravagance in the use of filter wash-water. The worst extreme—no floc at all—due to under-dosing with coagulant, will have the disastrous effect of producing a turbid filter effluent, since the non-flocculated colloidal matter will pass, unchanged, through the basins and the filter sand.

At Alexandria, the principal aim of all treatment, apart from the elimination of living biological material, is to effect the precipitation in the settling basins or the clarifiers of 90 per cent. or more of the suspended matter from the incoming water. At the same time, the 10 per cent. or less of solids still left in suspension must be composed of particles of such a size and condition that it will be removed completely during rapid sand filtration. Many chemical coagulants have been tried, including lime in excess, but the aluminium-sulphate process has been found to be best suited, economically and practically, to the exigencies of local conditions.

The development of a design for a sedimentation tank which would give the highest possible efficiency has been the subject of small-scale

experimental investigations at Alexandria for many years, and the purpose of this Paper is to give a brief outline of the experimental work and the findings that have contributed to the development of the type of clarifier recently installed in the Company's new waterworks at Siouf, Alexandria.

Systematic work on a laboratory scale was commenced some 11 years ago, with a study of the effects of stirring freshly aluminium-sulphate treated water with paddles revolving at different speeds in rectangular and circular vessels. In circular vessels, it was found that almost any practicable speed of rotation was beneficial to floc formation, optimum effect being obtained at a speed of about 85 revolutions per minute. In square and rectangular vessels it was found that agitation capable of producing the slightest turbulence caused newly-formed flocculi to be broken up, giving what has since been so aptly described, in American practice, as "pin-head floc." It transpired that for every type of stirring paddle, there exists a certain critical speed of rotation for the production of the heaviest and most desirable kind of granular coagulum. This speed is dependent upon the form of the paddle and the relative size and shape of the containing vessel in which it is mounted, due allowance being made for the length of time during which water might be expected to be retained in the vessel under works process conditions. In rectangular containers, the low speeds, about 10 revolutions per minute, whereby a floc-rolling effect, rather than an indiscriminate mixing or turbulence, was produced, were invariably superior to higher speeds in the production of dense and large flocculi. This, and other work of a similar nature, led to a closer study of the processes of flocculation and sedimentation as they were actually occurring in the settling basins of the Rond Point works. This works, at which the entire supply for the city was treated in 1928, had steadily increased in size, over a period of 25 years, from an output of from 5·4 million to 21 million gallons per day, and all extensions had been made to conform exactly to the design of the first settling-basins and filters installed in 1903*. Until 1928, very little had been published concerning the clarification mechanics of turbid river-waters, and such experimental work as the above imposed a timely emphasis on the necessity, not only for correct coagulant doses, but for a closer study of the design of the reaction tanks and the disposition of their baffles and guide-walls. The different types of floc that could be produced by different arrangements of stirring led one to suppose that the employment of an ideally suited method of water movement throughout the basins, whether induced mechanically or by guide-walls, could be expected to produce an improved effluent and a pronounced economy in the consumption of coagulant.

At Rond Point works there were, in 1928, six rectangular concrete settling-basins working in parallel. Each basin holds 985,000 gallons,

* H. R. C. Blagden, "The Filtration-Works for supplying the Town of Alexandria with Potable Water." Minutes of Proceedings Inst. C.E. vol. CLXVI (1905-6, Part IV), p. 316.

is 170 feet long, 80 feet wide, 12 feet deep, and has a rated capacity of 110,000 gallons per hour. Before subsequent alterations were commenced, water was admitted to each basin through two ports placed near the bottom, a few feet either side of the centre. (*Figs. 1.*) At the middle of the length of each basin, two transverse walls existed; the one nearer the

Figs. 1.

ELEVATION.

PLAN.

inlet acted as a submerged weir, whereas the second was a wall along the base of which were six ports allowing water to flow into the bottom of the second section of the basin, after having passed over the weir wall.

Investigation.

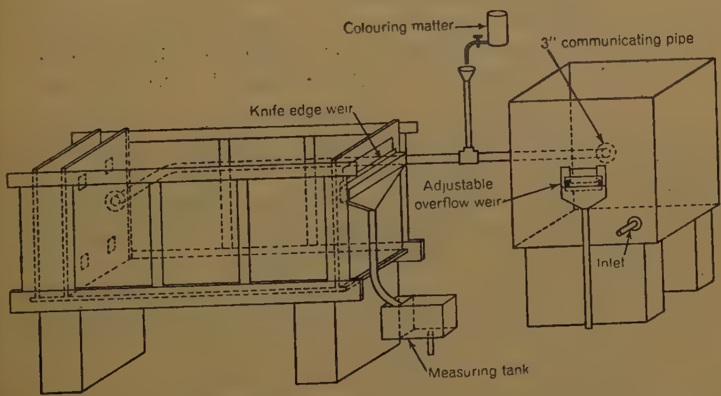
To ascertain whether or not the disposition of the inlet, outlet, and two intermediate walls was conducive to the best possible circulation, flow-paths were tracked in terms of increased alkalinity by use of quicklime added at the inlet. One of the basins working at 110,000 gallons per hour was isolated, and, at a recorded time, milk of lime was added to the influent for 1 hour in such quantity that the alkalinity of the influent was raised 2·0 *p*H units above that of the water already in process of clarification. Theoretically, the ratio between the flow-rate and the capacity of the basin (that is, " the retention time ") was such that all water entering the basin should have occupied 8·9 hours for its passage from inlet to outlet. In actual fact, it was found that limed water began to escape from the basin 3·25 hours after the time of commencement of lime addition. From this result it was obvious that there existed in every basin large volumes of semi-stagnant water, the presence of which reduced their effective capacities by some 60 per cent.

The determination of the regions of streamline flow and quiescence in such a large type of basin would have been an extremely difficult undertaking, which, even if brought to a satisfactory conclusion, would still have left unattempted the more subtle task of developing the most practical and effective method of modifying the existing construction of the basins to

give better distribution throughout their volumes. It was finally decided that the best method of attacking both problems would be to perform experiments in a small glass-sided model of the standard settling-basin.

A model was then constructed which, although not geometrically similar to its larger prototype, was of a convenient size to permit of close observation, through its sides, of flow variations for any arrangement of guide-walls. Its dimensions were :—length 5 feet 6 inches, width 3 feet 6 inches, depth 2 feet, and volume 28·5 cubic feet (or 240 gallons). The glass side-panels were laid flush with the inside of the framework to allow moveable weirs or baffles (made from galvanized sheet with rubber over-size edges) to form a seal along the sides and bottom of the tank. Water was fed into the model at a predetermined rate and, to ensure a constant rate of flow, the supply tank was fitted with an adjustable weir overflow

Fig. 2.



whereby the level could be kept constant. The outlet was over a knife-edge weir extending across the full width of the tank and, by a suitably arranged trough, the water passing this was led into a volume-calibrated measuring tank, *Fig. 2.*

All experiments were first performed with filtered water and, whenever flow paths were to be observed, a solution of potassium permanganate was added to the influent such that the colour differentiation would be well marked between the tinted water and that through which the stream flowed or diffused. The experiments were then repeated with freshly-flocculated raw water drawn from the inlet pipe of the No. 1 settling-basin at the works. Thus, the water used in the second set of experiments was in the same condition as the main supply entering the settling-basins for sedimentation, and had a transparency of from 2 to 10 centimetres, depending upon the condition of the raw water and the time of the year. Although the latter observations of the direction of flow were, perforce, confined to within a few centimetres of the glass sides, they were exceedingly informa-

tive, particularly when the subsidence properties of the floc were in question.

In the initial experiments it was found almost impossible with any given arrangement of baffles to obtain similarity of results at different times. This failure was soon traced to uneven distribution of temperature throughout the water in the model and to temperature differences between the contents of the basin and the stream of coloured or floc-laden water: temperatures differing by as little as 0·2° C. were sufficient to cause irregularities amounting, sometimes, to complete inversion of flow-line. Subsequently, by waiting for the system to attain complete thermal uniformity before observations were commenced, it was found possible to reproduce any series of results.

Sudden changes in rates of flow is a normal condition under which the works settling-basins have to operate, since groups of pumps have to be started and stopped in such a manner that the night flow falls to little more than one half of that delivered during the daytime. Also, the temperatures of the influent and the main body of the contents of the basins often differ by 2–3° C. This is explained by the fact that Egypt is a country where night and day air-temperatures differ by 10° C. or more during 9 months of the year. Consequently, in view of the shallowness of the Mahmoudieh canal, and hence its susceptibility to temperature changes, the water which enters the settling-basins from 7 a.m. to 10 a.m. is usually slightly colder than their contents, whereas that from 3 p.m. to 8 p.m. is 1·5–2·0° C. warmer. Thus, the question of flow through the basins is largely influenced by small variations in the temperature of the water admitted to them for treatment. Any attempt to improve their efficiency must have, as primary objectives, the design of guide-walls that will tend to cause water to flow through the basins in such a way as to damp out any flow abnormalities due to temperature changes, and at the same time be equally efficacious whether the basins are being operated up to full or half capacity.

It was for these reasons that the first two series of experiments were devoted to the determinations of (*a*) effects produced by variations in flow rates, and (*b*) directional changes in flow caused by differences in temperature between the influent and the contents of the model-tank. The baffles in the model were arranged so that they reproduced those in the settling-basins, and the maximum flow was fixed at 5 gallons per minute—a rate which gave a theoretical retention period of 48 minutes.

The results illustrated in *Figs. 3* and *4* show the changes in direction of flow when temperature conditions throughout the system were constant and the rates of ingress were half and full flow respectively. *Figs. 5* and *6* show the respective changes in flow direction which occurred with a steady flow of 5 gallons per minute, but with the temperature of the influent varying 0·5° C. below and above that of the contents.

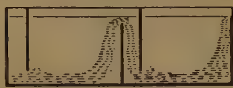
The flow through the works settling-basins must have varied in much

the same way as is shown on *Figs. 3* to *6*, and this explained not only the short circuiting of water in its passage through the basins, but also the increase in the turbidity of their effluents during the forenoon, whenever extra pumps were put into service. Another periodic upheaval and increase in turbidity invariably occurred at about 2 p.m., particularly throughout the summer months. This could now be attributed to the

Fig. 3.

Experiment 1.
Rate of flow: 12 litres per minute,
temperature constant

Fig. 4.

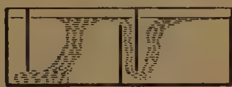


Experiment 2
Rate of flow: 23 litres per minute,
temperature constant

Fig. 5.

Experiment 3.
Rate of flow: 23 litres per minute,
inlet temperature: −0·5° C

Fig. 6.

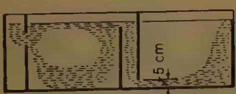


Experiment 4.
Rate of flow: 23 litres per minute,
inlet temperature: +0·5° C

rapid rise in temperature of the raw water above that of the contents of the settling-basins which occurred as the raw water passed, after sunrise, from the Mahmoudieh to Rond Point works through the Company's comparatively shallow 1¼-mile-long adduction canal.

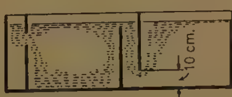
Subsequently, further series of experiments were made. *Fig. 7* shows the effect produced by admitting water to the top, instead of to the bottom, of the first compartment. *Fig. 8* shows the effect of using the

Fig. 7.



Experiment 5
Rate of flow: 23 litres per minute,
temperature constant

Fig. 8.



Experiment 6.
Rate of flow: 23 litres per minute,
temperature constant

same arrangement as illustrated in *Fig. 7* except that the area of the opening under the curtain baffle was doubled and the velocity halved.

Frequent repetitions of experiments 5 and 6 (*Figs. 7* and *8*), and comparison of the results, showed that in both cases the flow in the first compartment was always the same. With the larger opening under the baffle-wall (*Fig. 8*) the water turned upwards, through a right angle, immediately on entering the second compartment, thus indicating that its dynamic energy was insufficient to overcome the inertia of the mass of water it encountered on changing its direction round the lower edge of the baffle plate. In experiment 5 (*Fig. 7*), the higher velocity and energy of

the water due to the reduced opening was sufficient to set in motion the mass on to which it impinged, and a forward movement was imparted to the water and sludge lying fairly near to the bottom of the tank which, towards the outlet end, was deflected upwards to the overflow weir. So long as an isothermic condition governed the influent and the contents of the model the water always behaved in this manner, but, when the temperature became more than 0·5° C. higher than that of the water in the lower strata of either or both sections of the model, the flow in experiment 5 (*Fig. 7*) changed to resemble very closely that shown in *Fig. 8*; that is to say, it tended to rise to the surface. Conversely, when the influent temperature was 0·5° C. below that of the contents, the flow lines shown in *Fig. 7* would be obtained under the conditions of experiment 6.

Fig. 9 illustrates the flow produced when four baffles were set to give

Fig. 9.

Experiment 7.
Rate of flow: 23 litres per minute
temperature constant

the classical "over and under" system. Although the detention period was increased in compartments 1, 2, and 4 with this arrangement, flow was rapid and variable in compartments 3 and 5, especially when any changes occurred in temperature or velocity.

From the foregoing, which is merely a brief survey of a prolonged period of investigation, it was obvious that, with any of the arrangements studied, the conditions contributing to effective sedimentation of flocculated silt particles were far from satisfactory. Large quiescent zones were formed which, either with changes in flow-rates or variations in the temperature of the influent, were liable to be partially rotated in a vertical sense and to carry in their train excessive quantities of previously-settled sludge.

Preliminary Conclusions.

The conclusions drawn from the work were as follows:—(*a*) Vertical motion and eddies must be prevented if the sedimentation of the floc particles is to be effective. In all experiments it had been found that the suspended floc followed the stream, settling downwards slowly when the stream flowed downwards or horizontally, but being lifted whenever the stream took an upward path. (*b*) Horizontal eddies with linear velocities up to 10 feet per minute have, for all practical purposes, no floc-supporting value. They are conducive to a snowball-like floc-rolling action which produces denser, larger, and less buoyant particles than when there is no

motion at all. The rate of sedimentation is thus aided. (*c*) The critical velocity at which it becomes impossible for floc to settle is a function depending largely upon the character of the vertical eddies, if present. Another fact which emerged very strikingly was that, even with exceedingly small linear velocities, Newton's Third Law always holds good—a point which has usually been overlooked when tanks of the above type have been designed. This being so, an incompressible liquid contained within inelastic walls cannot do otherwise than bring about the reactions to flow demonstrated in the experiments, and it follows that uniform horizontal motion throughout the whole mass of water in a rectangular tank can only be obtained by having inlet, outlet, and intermediate channel all of the same cross-sectional area, for there must be no change in velocity either when the water enters, when it leaves, or during transit. Thus, the ideal conditions for water clarification approximate to a channel of uniform cross-section and great length, through which water must flow at a certain critical velocity. This velocity, whilst dependent upon the specific gravity and turgescence of the floc particles, is also proportional to the length and depth of the channel.

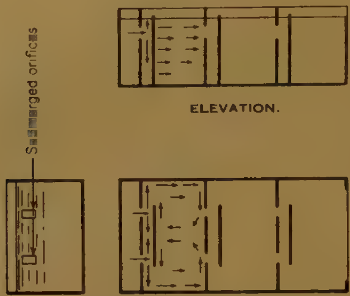
Modifications Based on the Results of Investigation.

Although the rigid application of such principles to the problem to be dealt with at Alexandria was not practicable, the view was confirmed that the ideal to be aimed at was to keep the stream moving as horizontally as possible and to avoid any abrupt downward movements, for these must always produce an uplift of silt in other parts of the system. Such a condition could only be achieved by the creation in the basins of large horizontal eddies which, besides having no floc-supporting value, also offered an indirect method of lengthening the path or " channel " through which all the aluminium-sulphate-treated water would have to pass. An attempt was made to redesign the model-tank so that those same reactions, which had previously disturbed the uniformity of flow, would be harnessed and used in a manner likely to produce a more stable and reliable type of circulation than had been possible with the baffles arranged as in the original design.

The modifications finally adopted were evolved from a study of the behaviour and direction of flow in the first compartment, with the model arranged as shown in *Fig. 9*, where it will be noticed that the incoming water is deflected downwards when it reaches the inlet baffle-wall. Using this as a working basis, another baffle was placed close to the two inlet ports and of sufficient length to overlap them, leaving a gap between each end and the side walls (*Figs. 10*, p. 32). The object of this was to influence the direction of flow so that it would turn horizontally, as well as downwards, towards the side walls. The resulting flow of the water is shown in *Figs. 10* (plan view). The divided streams, on striking the new baffle-wall,

turn inwards towards each other and then flow backwards and outwards. Once the water had escaped from this narrow passageway, two horizontally moving streams were formed in the main compartment, one moving in an approximately clockwise direction from one side and the other in a counter-

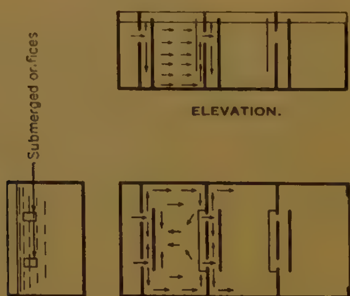
Figs. 10.



Rate of flow: 23 litres per minute
temperature constant

clockwise direction from the other. The outlet from the compartment was arranged to reproduce its inlet ports exactly, and water leaving the first section then flowed progressively through three more of similar construction. The fault in this arrangement, however, was the persistent formation of a wedge-shaped zone of water below and in front of the outlet ports used

Figs. 11.



Rate of flow: 23 litres per minute
temperature constant

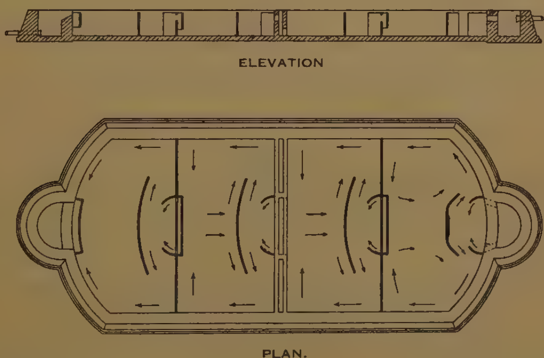
for passing water from one compartment to the next. This remained at an almost uniform temperature, and was subject to all the turnover effects noted in experiments 5 and 6 whenever any sensible and sudden change took place in the temperature of the incoming water. This dead patch was ultimately made to circulate by placing a curtain baffle in front, and on the inlet side, of these ports, as shown in *Figs. 11*, closed at the sides and

open along its entire lower edge, whereby the draw-off was taken from the lower part of the thick end of the wedge. The effect of this alteration was to eliminate practically all the effects of temperature differences in the tank and to increase the detention period from approximately 5 minutes, with the baffles arranged as in *Figs. 3* to *6*, to about 35 minutes in *Figs. 11.*

Results of Modifications.

The results observed with the model in its final form were so promising, especially in the manner in which thermo-motive changes in flow were obviated, that it was decided to alter the No. 1 works settling-basin and to reproduce, as far as possible, the same design. *Figs. 12* show the manner in which this conversion was performed. Flow–time trials in No. 1 basin were again made with lime solution and on this occasion it was found that

Figs. 12.



SETTLING BASINS AS MODIFIED TO REPRODUCE MODEL-EXPERIMENTS (*Figs. 11*).

the retention period had been increased to 7 hours 20 minutes, or 82 per cent., instead of 40 per cent. of the calculated figure given by the original design. Daily samples were taken, for analysis, from No. 1 basin for one year, and the results, when compared with those of the effluent from basins 2–6, proved to be superior in every respect. To quote only one figure, the average clarity of the effluent from the converted basin was 60 centimetres as against 41 centimetres for the others, the same aluminium-sulphate dose being used for all. The clarity of the No. 1 basin effluent being unnecessarily high, it could be assumed that the conversion of the five other basins to the new design would speedily pay for itself by the economy which would be effected in aluminium-sulphate consumption. On the completion of the 1 year's trial period, basins Nos. 2 to 6 were converted to the new design, and a seventh basin was built, only differing from the other six in the manner of sludge discharge.

From this time onwards, a remarkable improvement was noticed in the ease of treatment control, the purity of the effluent, percentage deposition of solids, and aluminium-sulphate consumption. The annual average consumption for the 10 years preceding the alterations was 35·5 parts per million and that for the 7 years following, 25·8 parts per million. Organic matter in the effluent, as measured by albuminoid ammonia, fell from 0·141 part per million (1928–1930) to 0·107 part per million (1931–1935). The improvement in the chemical quality of the effluent was largely due to the elimination of the "turn-over" effects which had previously occurred whenever the rate of flow through the basins had been changed. The modified basins showed a remarkably satisfactory responsiveness to changes in flow, no matter how sudden or how drastic.

As originally constructed, the greater portion of whatever sludge was deposited in the basins was found to collect in the first section. With the newer design the same amount settled out in the first two compartments, but a considerable quantity was also deposited in the last two compartments. Gravimetric estimations of the suspended matter contained in water entering each section gave the results displayed in Table II, and showed a 93·2 per cent. removal by the whole basin.

TABLE II.

Sample point.	Clarity: centimetres.	Suspended matter: parts per million.	Removal of original suspended matter in each section: per cent.
Water entering basin: first section	6·3	232·2	
			39·3
Water entering second section of basin	17	140·8	
			26·1
Water entering third section of basin	23	80·3	
			16·0
Water entering fourth section of basin	32	43·2	
			11·8
Water leaving basin	46	15·8	
Total suspended matter removal			93·2

SIOUF WORKS.

In 1931, a decision was taken by the Alexandria Water Company to build a new complete waterworks on the eastern side of the town, in order to supplement the output from the Rond Point works and so improve the pressure and supply to the extending outlying districts. The works, of which the first quarter was to come into operation in 1935, were to be planned for an eventual total daily output of 44 million gallons, and once again the raw water was to be drawn from the Mahmoudieh canal.

In brief, the objects to be encompassed were :—

(a) destruction and removal of plankton (algae, diatomaceae, and crustaceae) from the raw water before coagulation and sedimentation ;

(b) adequate and correct addition and mixing of coagulant to the plankton-free raw water ;

(c) proper conditioning of the freshly coagulant-treated water with a view to the production of a type of floc possessed of qualities most likely to favour rapid sedimentation ;

(d) deposition of the greatest possible amount of flocculated suspended matter in clarifiers, before the water was delivered to the filters ;

and (e) inclusion in the clarifers of a means of daily or continuous sludge removal, as opposed to the older Rond Point system whereby, after running off the supernatant water into the town sewers, gangs of men squeegee the remaining sludge into a drain discharging into the sea.

The means employed for the removal of plankton, being outside the scope of this Paper, need not be referred to except for stating that this is achieved partly by algicides and partly by the use of rotating mechanical screens.

A specification was prepared for the requirements of the new works, and eventually the filtration section of one of the tenders submitted was accepted, the Alexandria Water Company undertaking to give serious consideration to the possibility of installing the apparatus suggested for clarification treatment. The chief stage consisted of sedimentation of coagulant-treated water in large circular basins, followed by secondary sedimentation in rectangular tanks. The circular basins, in which it was intended that most of the sludge would be deposited, had never been employed previously to deal with a water as turbid as that from the Mahmoudieh.

The inlet to the circular tank was at the centre, from which the water flowed outwards to a decanting weir and trough along the entire outer periphery. In theory, this design allowed flocculated water to issue from a series of vertical slots in a circular central stilling-column, and thereby ensured a perfect radial flow towards the outer wall, and a full utilization of the volume available for the purpose of sedimentation.

To those in Alexandria who had witnessed the experiments performed in the glass-sided rectangular model, it appeared that a far more likely effect would be that each stream diffusing from the stilling-column would, after impinging on the sluggish mass of water contained in the tank, have its motion changed from a horizontal to a vertical direction, and that the subsequent path of the incoming water would then be largely determined by the relative temperatures of the influent and the contents. If the in-

fluent was colder, then the floor-flow shown in *Fig. 7* (p. 29) would obtain: if warmer, the influent would tend to rise to the surface and stream straight across to the periphery. Moreover, during the summer months, when the water is most heavily laden with suspended matter and the greatest demands are made on the clarifiers, the upper stratum of water would, due to continued exposure to the sun, become warmer than the incoming water could ever be by several degrees centigrade, so that the flow would be along the bottom of the tank at all times. Consequently, any inclination towards sedimentation of floc particles would be frustrated. In addition to this drawback, the design did not take into account the considerable effect of wind on a tank of 110 feet diameter. With the exception of a few days every year, there is always a wind, blowing either from the north or the south, which is usually strong enough to whip up the surface of such an expanse of water into wavelets. Neglect of this factor would entail the establishment of a hydraulic gradient across the tank, and a greater proportion of water would be decanted over the windward than the leeward segments of the peripheral weir. This was later proved to be correct, when experiments were being made with a model constructed with a complete peripheral decanting weir: the flow was always greater on the windward side of the tank, that is, the flow tended to be against the direction of the wind. Thus, in whichever light the design was viewed, it was felt that the time of passage of water through the tank could only be some fraction of the time intended, for displacement throughout the tank would not be radially uniform.

These views were communicated to the original designers and the opinion advanced that if the criticisms cited were correct, then large masses of stagnant water would exist in the tank which, as learnt from previous experiments, would be prejudicial to sedimentation and favourable to the proliferation of algae. The suggestion was also made that if a rotatory instead of a radial motion could be imparted to water entering a circular tank, then floc suspended in this stream would be far more likely to settle, since wind-effects and temperature differences, the great deterrants to floc settlement, would be so minimized as to render them unimportant.

Finally, it was agreed that, before embarking on the construction of a full-size clarifier, the best means of ascertaining the true facts would be to have recourse, once again, to an experimental model, the diameter of which was arbitrarily fixed at 16 feet 5 inches. The capacity of the model was 2700 gallons.

Design of the Model.

The various units employed in the reduction of the other dimensions and velocities given for the full-sized clarifier were determined by use of the mathematical principles for model-experiments described by Sir Thomas

Stanton in the James Forrest Lecture of 1931*. Thus, as it had been decided to fix the diameter of the full-sized clarifier at 110 feet, all linear dimensions for the model had to be reduced from those shown on the drawings for the proposed clarifier in the ratio 1 : 6·73.

Units of mass and volume: in full scale the unit of mass would be $\frac{62 \cdot 4}{32 \cdot 2}$, or 1·94; so, for similarity, the unit of mass in the model had to be $\frac{1 \cdot 94}{6 \cdot 73}$, and the unit of volume of the water-content of the model $\frac{1}{6 \cdot 73}$.

Unit of time: since the acceleration due to gravity is common for both full size and model, and is of dimensions $\frac{L}{T^2}$, then the ratio between the unit of time for the model and the unit of time for full size must be the square root of the corresponding ratio of linear dimensions: that is, the unit of time for the model is $\frac{1}{\sqrt{6 \cdot 73}} = \frac{1}{2 \cdot 59}$.

By axiom, velocity in model = velocity in full scale $\times \frac{L}{T}$.

Since in the full-scale clarifier it was proposed that a de-sludging bridge mechanism should make one revolution in 20 minutes, giving a peripheral velocity of 3·45 inches per second, then for similarity in the model this velocity had to be fixed at:

$$3 \cdot 45 \times \frac{\frac{1}{6 \cdot 73}}{\frac{1}{2 \cdot 58}} = 1 \cdot 32 \text{ inch per second,}$$

or 7·65 minutes per complete revolution. It had been agreed that the flow through the full-scale clarifier was to be 24,200 gallons per hour. Thus, the flow through the model became $\frac{24{,}200}{6 \cdot 73}$ = 3596 gallons per hour.

Included in the experimental layout was a small primary conditioner placed about 19 feet 8 inches distant from the clarifier model and fitted with a stirring paddle which could be operated by hand. A solution of coagulant (aluminium sulphate) was fed by gravity through a tube to the bottom of this primary conditioner. Such an arrangement corresponded to that suggested for the two works clarifiers which, it had been proposed, would be supplied with "conditioned" water from one common primary conditioner connected to the clarifiers by a system of ducts and piping.

In the model, the conditioner was connected to the clarifier by an open trough fitted with a V-notch for the control of the rate of flow. After

* Minutes of Proceedings Inst. C.E. vol. 232, pp. 404–406.

the V-notch there followed a hydraulic jump into a small chamber, from which the water was fed by a 6-inch diameter pipe to the central inlet, or stilling-chamber, of the clarifier. In later experiments this V-notch was transferred to the outlet side of the model.

After entering the clarifier through the central stilling-chamber, the water flowed radially outwards to a peripheral collecting trough. This trough was an open annular channel fitted with an effluent pipe, the diameter of which was well in excess of that required to prevent the accumulation of any water in the trough.

No scraping mechanism was provided for the evacuation of deposited sludge from the model, but, in place of this, a wooden frame fitted with vertical slats was mounted in the clarifier so that it could be revolved about the central inlet by hand. For purposes of comparison this arrangement simulated a scraping structure, and, although it could never be turned slowly enough to imitate actual large-scale working conditions, it represented the obstruction to flow that might be created by such a structure.

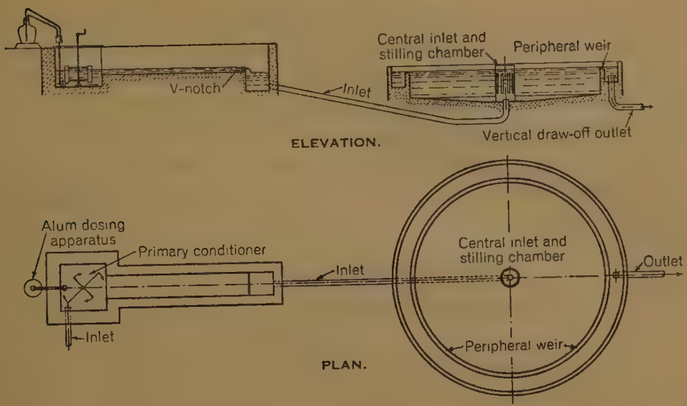
Mahmoudieh canal water was treated with the same aluminium-sulphate dose as was being used in the works at the time of each experiment, and the water was then admitted to the clarifier at, within narrow limits, 3930 gallons per hour.

Experiments.

Group 1 (*Figs. 13*). The model was put into service, and allowed to run long enough, without intermission, to discount all possible errors due to unstabilized temperature effects. It was then noticed that unless the aluminium-sulphate dose was greatly increased the water left the model with practically the same turbidity as it had on entering, apart from a slight improvement that occurred as a result of deposition of some of the larger flocculi in the primary conditioner and in the conduits to the clarifier.

Flow–time tests were made by adding colouring matter or soda to the influent and then examining the effluent continuously for these substances until such time as their presence was detected. These trials led to an undeniable confirmation of the belief that this type of clarifier would have proved unsatisfactory, for, invariably, large quantities of alkali-treated water could be detected at the decanting edge within from 12 to 15 minutes of admission to the clarifier. Moreover, it was noticed that when the temperature of the influent was colder than the contents, nothing was seen of the coloured or alkalized water from the time it left the central stilling-well until it reached the peripheral weir. On the other hand, if the influent was warmer, it streamed straight across the surface of the water to the weir edge. If the clarifier had been 100 per cent. efficient, then it should have required 3·4 hours for all the water to pass through it. Thus, the

Figs. 13.



inference to be drawn from the 12–15-minute retention intervals was that the clarifier was only 7 per cent. efficient.

Group 2. The principle of central inlet and peripheral outlet were adhered to, but observations were made of the effects produced by variations in the size, position, and angles of the slots in the central inlet column: none of these alterations produced any improvement on the previous design.

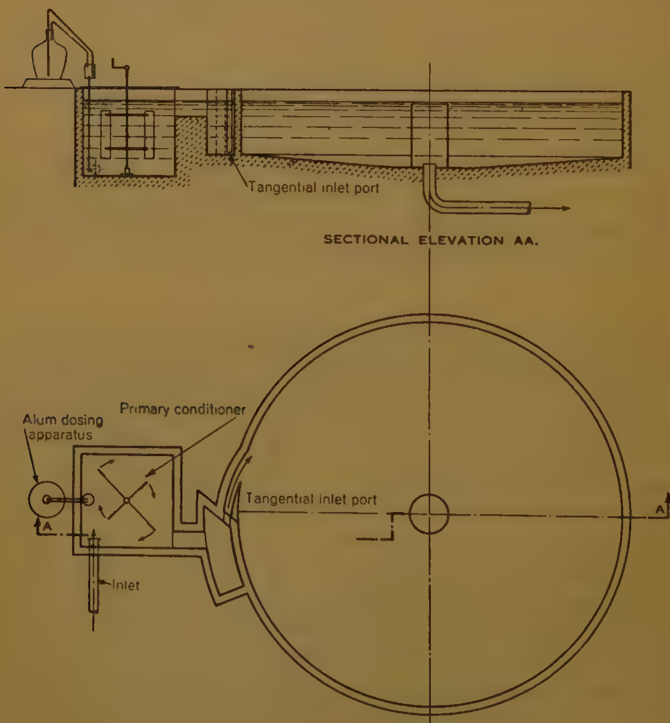
Group 3. Radial flow was again adopted, but with the direction of flow reversed to go from the outer peripheral weir to a central draw-off. Once more, attention was concentrated on the design of the central draw-off column. A simple knife-edge weir was tried at various depths below the water-level, then slots, and, finally, a variety of shielded bellmouths. All these experiments were abortive as a consequence of the production of an induced updraft around the central draw-off which had, in effect, been turned into a Borda orifice outlet with an uplift on its outer peripheral wall. Immediately water began to flow into the central draw-off, an inward flow was set up along the floor of the basin which carried along with it whatever floc may have been deposited, so that in the end there was little or no reduction of the solid matter suspended in the incoming treated water. Far more water was drawn up from the base of the column, irrespective of temperature differences, than ever flowed into it from the upper strata. Flow through the basin was even faster than in the previous groups of experiments. In an endeavour to minimize or overcome the suction effect, several types of shields were fitted around the central column at different heights to act as baffles to the "Borda stream", but without success, the increase in diameter only serving to deflect, and not to obviate, the updraft.

At this juncture it was agreed that the idea of a circular basin, operated

on the assumption of radial flow, whether from the centre outwards or from the periphery inwards, should be abandoned. At the same time, it was decided that it ought to be possible to arrive at a design for a circular clarifier which would give the desired efficiency, provided that the contents could be influenced to follow some kind of progressively narrowing or widening helicoidal motion about the centre. This decision was strengthened by the knowledge that a circular clarifier would have so much to recommend it in respect of its cheapness and simplicity of construction.

Group 4 (*Figs. 14*). The model was partially dismantled and then rebuilt so that the primary conditioner and its aluminium-sulphate-dosing gear became

Figs. 14.



a corporate part of the main basin. A duct, through the wall separating the conditioner from the clarifier, was made for the purpose of admitting conditioned water to the clarifier and was set so that the direction of entry would be tangential to the periphery: the area of this port limited the rate of ingress to 10 feet per minute. At the same time arrangements were

made to allow the treated water to be withdrawn from the basin by way of the original central stilling-chamber, the top open end of which was chamfered off to form a slightly submerged knife-edge weir.

At the commencement, the new arrangement gave a certain amount of promise, but on continuing the experiments this proved to be illusory, due, as in the Group 3 experiments, to the updraught and lifting of sludge from the floor of the basin in the neighbourhood of the central draw-off. However, during the course of these experiments it was remarked (*a*) that a slight increase in transparency occurred, (*b*) that temperature differences throughout the contents of the basin were extremely small, and (*c*) that the kinetic energy of the effluent, in spite of its very low velocity, was sufficient to cause a noticeable rotation of the water already in the basin—a somewhat surprising and encouraging result.

From these findings it was presumed that if a satisfactory device could be discovered for the withdrawal of sludge-freed water from a circular clarifier, having a tangential or single-entry port on the periphery capable of causing the contents to follow a circular path, then it might be possible to secure a high degree of clarification efficiency.

Group 5 (*Figs. 15*, p. 42). The model was again rebuilt. The central stilling-chamber, was retained as an axis of rotation, but was heightened to project well above the water-level. The tangential inlet port employed in the previous group of experiments was left unchanged, whereas the draw-off from the basin, instead of being from the centre, was from the periphery. The revised draw-off was the same as had been employed in the radial-flow experiments of Groups 1 and 2, and was by cascade over a complete circumferential weir into a surrounding collecting-trough. By the use of a discharge pipe of large diameter from the trough, decanted water was prevented from accumulating in this outer trough.

The efficiency of the basin then increased to about 25 per cent.—a definite improvement on any previous figure, but still far from that of either the Rond Point basins or other well-known rectangular clarifiers.

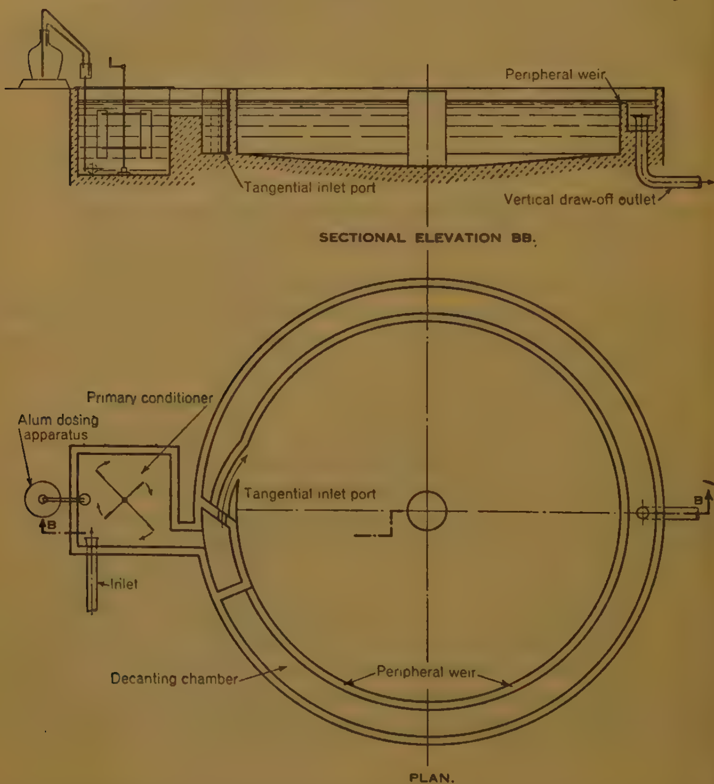
Addition of dyes to the influent showed that a large volume of stagnant water existed around the central column, and that an uplift was occurring against the inside face of the basin, that is, up and towards the inner face of the decantation weir.

Group 6. The previous group of experiments had advanced the investigations a stage further by revealing that the uplift occurring in the vicinity of the decanting weir was influenced by the velocity with which water approached and then passed over this weir. These new experiments were devoted to the discovery of a type of draw-off or decanting chamber which would eliminate the peripheral updraft.

It was reasonable to suppose that, if the velocity of approach to the weir edge could be reduced to a figure where it would be almost subordinated to the angular velocity of the rotating mass, then all tendencies

towards abrupt vertical displacement should be damped out and a
increased efficiency would result. The obvious method of attempting t
secure this compensation was to submerge completely the decanting we
and increase the depth of water flowing over its edge. To this end, th
outlet pipe from the collecting trough was throttled until the trough itse
was filled and the general water-level in the system was 1 inch above th
top edge of the peripheral decanting weir.

Figs. 15.

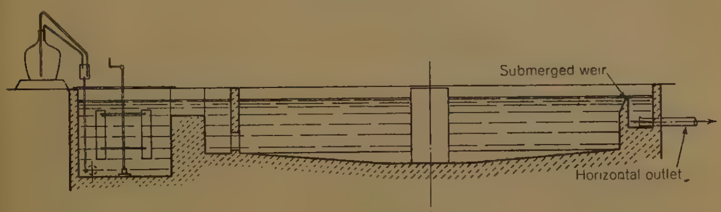


This arrangement improved matters slightly but the uplift still con-
tinued to be very pronounced in the vicinity of the draw-off pipe, which
was placed vertically in the collecting channel. It was found that th
disposition of this pipe exercised a surprisingly powerful influence on th
functioning of the basin. Its position and orientation continued to b
changed until it was established that the best type of draw-off pipe wa
one fitted low down and projecting, horizontally, well into the trough an
at a point slightly behind the point of ingress of the influent to the basin

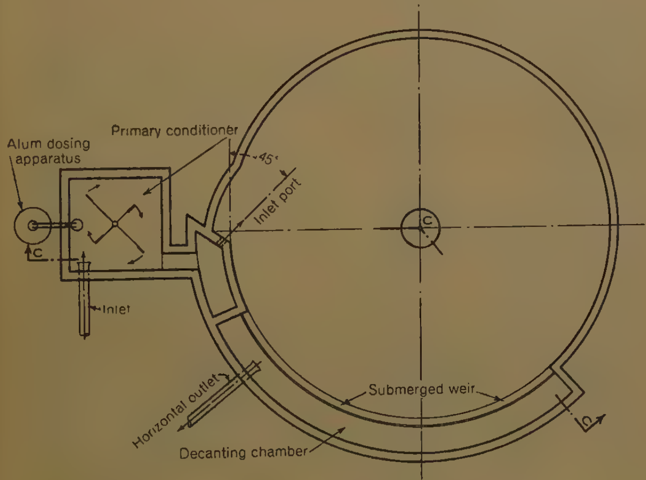
he effect of this arrangement, coupled with the increased depth of water bove the weir edge, was to create a horizontal draw-off in the collecting ough extending a great distance either side of the pipe opening, whereby e flow over the peripheral weir became more nearly uniform throughout s length, with the consequent desired reduction in the velocity of approach the neighbourhood of the draw-off pipe.

roup 7 (*Figs. 16*). A study was then made of the effects produced (*a*) by

Figs. 16.



SECTIONAL ELEVATION CCC.



PLAN

altering the size and length of the collecting trough, and (*b*) by increasing the extent of submergence of the top edge of the decanting weir below the top water-level. This work brought to light many interesting and hitherto unsuspected details, which exercised a vital influence on the degree by which the retention period could be lengthened or shortened.

A compromise on these variants produced a decanting chamber abutting on to the clarifier basin and extending along one-third of its periphery from a point slightly behind, and in the contrary sense to, the inlet port

(*Fig. 17*). The decanting edge, which was integral with the peripheral wall of the clarifier, had, in order to obtain the best possible draw-off conditions, to be set at an angle ranging between 28 and 40 degrees to the floor of the basin, and the depth of water above the decanting edge was so regulated that its velocity was about one-tenth of that of the influent to the basin. Trials now showed that the basin was roughly 60 per cent. efficient and that the effluent, when using the same coagulant doses as in the works, was of reasonable purity.

Group 8. Attention then reverted to the design of the inlet, for temperature records and dye tests had shown that there still existed a considerable volume of stagnant water concentric with, and adjacent to, the central column of the basin.

It was eventually found that a satisfactory type of inlet was one which admitted water through a vertically-placed rectangular port extending from the floor of the basin upwards, and set in such a manner that water was directed into the basin at an angle to the tangent, the degree of which depended upon the rate of flow through the basin. It was found that by this means the whole of the water could be set in circulation as well as in rotation. Moreover, water which had already performed one or more revolutions and was carrying in suspension small but well formed flocculi, was cutting circumferentially across the biased path of the influent with its mass of freshly formed floc, and providing a supply of nuclei on to which the newly formed floc particles of the influent could attach themselves. This growth in floc size produced the highly desirable effect of increasing the inertia on each particle, by doing which the rate of deposition of sludge on to the floor of the basin was increased. From being of an amorphous and porous character, the particles acquired a good dense granularity.

Group 9. It has been remarked in the previous group of experiments that the size and condition of the flocculi entering the basin were not as satisfactory as could be obtained under laboratory conditions of stirring. In the development of this aspect of flocculation full advantage was taken of the valuable experience that had been gained during the experimental work on the Rond Point basin model, and this last group of experiments was devoted to perfecting the design of the "floc conditioner" and its stirring gear.

This was a rectangular chamber into which the freshly aluminium-sulphate-treated water was introduced before admittance to the clarifier. It was fitted with two sets of specially-designed rotating paddles, which caused a water movement in the chamber. This movement created a multitude of small slow-moving eddies in the vortexes, of which fine floc particles were thrown together and acquired a diameter of from 1 to 2 centimetres before being discharged into the main clarifier. Once the conditioned water had been admitted to the clarifier, the greater portion of the silt sank to the bottom immediately and the little that still remained

Fig. 17.

MODEL-CLARIFIER USED IN GROUP 7 EXPERIMENTS.

5213.

Fig. 18.

CLARIFIER AS BUILT.

ı suspension was soon subjected to the beneficient influence of the pre-ɔrmed floc it encountered as it was discharged across the slow-moving ırcumferential stream of partially clarified water which had already ɔmpleted one or more revolutions of the basin.

The volume of the conditioner was finally fixed at roughly one-tenth of ıat of the clarifier, and its ratio $\frac{\text{capacity}}{\text{output per hour}}$ thus became 0·48 : 1. 'he corresponding ratio for the clarifier was 4·25 : 1.

In passing, it should be mentioned that this expression for correlating ow and capacity was adopted throughout as being a more correct and epresentative term than "retention period"—the one in current use. 'he expressions "detention period" and "retention period", so often ncountered in descriptive literature and manufacturers' tenders, are allacious in that they imply that every drop of water that enters a basin f a specified "retention period" or "detention period" remains in irculation in the basin for that length of time before being discharged. ince convection currents set up by changes of wind velocity, of tem-erature, and of water input, can, according to the efficiency of the design f the basin, produce a fast superficial flow and a semi-stagnant sub-strata, uch a specific and binding term as "hours detention" is distinctly mis-eading.

Final Design.

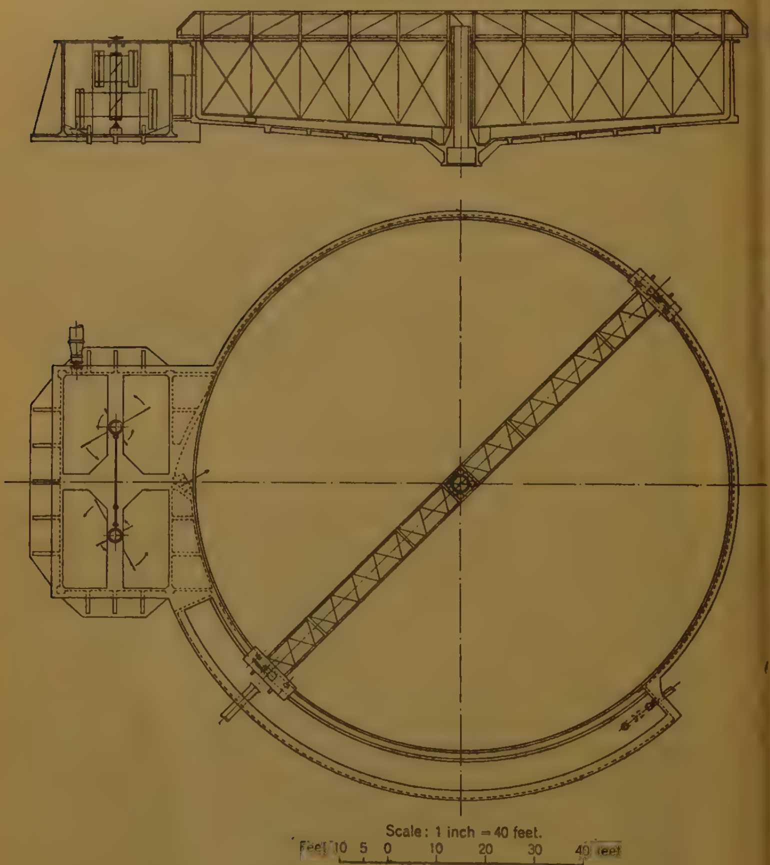
The experimental stage of the investigation was now considered to be t an end, and a series of trials were embarked upon under the worst con-litions likely to be encountered during a flood season. The model of the onditioner and clarifier combination emerged very successfully from these rials, and it was decided to proceed with the construction of two clarifiers ach of 110 feet diameter, to be enlarged replicas of the 15-foot-diameter xperimental model (*Fig. 18* and *Figs. 19* (p. 46)).

For the purpose of de-sludging the clarifier a diametric bridge was lesigned with an infra-structure fitted with inclined scraper blades which, n use, gather the mud to a discharge pipe at the centre of the floor. The whole load is carried by end carriages fitted with motors, each of 1 horse-power, wired in series to ensure equal tractive effort at each end of the bridge. These are coupled through worm-and-pinion gearing to driving wheels moving along a peripheral rail. A cast-iron ring fixed on the entral column above the water-level acts as the pivot around which the bridge rotates, and horizontal rollers fitted to the bridge bear on this. This de-sludging mechanism is run for only 2½ hours per day, the minimum ime required to clear the floor of accumulated sludge, and it has been found that the basin works more efficiently when the bridge is not moving.

The Egyptian Government, to whom all public works schemes have o be submitted for approval before execution, insisted that, if the new

design were adopted, sufficient space should be left between the clarifie and the filter house to allow of the construction of secondary sedimentati tanks of the Rond Point type, in case the new clarifier, in its enlarged forr failed to prove as efficient as the results obtained with the model had l everyone to expect. These secondary sedimentation tanks have nev been built.

Figs. 19.



By April 1935 the construction of the full-size clarifiers had bee completed and they were put into commission. Since that time the have run continuously.

It should be mentioned that at each of the Rond Point and Siou works there is a very well equipped laboratory in the control of a com petent European staff. Samples are taken hourly for clarity determina

ons by the platinum-wire method, and portions of each of these samples e set aside in a common bottle to be examined chemically every 24 hours. ables III and IV * (facing p. 48) have been obtained from the averages of ese laboratory investigations, and give an accurate representation of the anner in which the clarifiers have responded to the demands made upon em. During the period under review three Nile floods have been dealt ith, that of 1938 being one of the worst since records were first kept in 387.

From whatever angle the accompanying laboratory results are con- dered there can be but one conclusion, namely, that the clarifiers have roved fully capable of dealing with Nile water in a thoroughly satis- actory manner at all times.

On p. 28 it was pointed out that one of the conditions under which he pre-filtration plant at both works has to operate is an ever-varying nd suddenly changing rate of flow through them. With the circular larifier just described the disturbances likely to be caused by such varia- ions are effectively contended with. The influent, instead of encounter- ng an inert or sluggish mass of water as might be the case with a basin esigned on a principle of straight-line flow, joins a stream of water which s already moving in approximately the same direction as itself. Thus, ompensation for any increase or decrease in the kinetic energy of the nfluent is immediately provided by a corresponding change in the tan- ential velocity of the contents of the clarifier. This has been confirmed n practice whenever it has been necessary to shut down one of the clarifiers or painting. With both clarifiers working in parallel at 75 per cent. of heir rated capacity, it has been found possible to shut one out in the small nterval of time required to close the inlet valve and pass the whole flow that is, from 25 per cent. under-load to 50 per cent. over-load) through the other clarifier without producing any sensibly deleterious change in the effluent or any necessity for the use of a higher dose of coagulant. This ndifference to variations in flow rates also applies to temperature changes and is a somewhat striking tribute to the flexibility of the apparatus when working under adverse local conditions. Analytical and other relevant igures for one such over-load period are shown in Table IV. This aspect of the responsiveness of the modified Rond Point basins and the circular clarifiers to rapidly altered flow-conditions suggests that similar principles might be profitably applied to the design of clarification plant for certain industrial processes, particularly sewage treatment, where generous allowance always has to be made for abnormal margins of storm- water flow. Many sewage-works employ rectangular primary settling- tanks which, at a very small cost, could be altered to reproduce the Rond Point basin design, and it might be of value to all interested in this and

* Table IV has been abridged for publication by the omission of certain lines of figures; the mean values, however, are still in the original form.—Sec. Inst. C.E.

kindred problems to know the results obtained from such a conversion during storm-water periods. Also, baffling of small storage reservoirs along similar lines might go far to solve some of the problems connected with the zoning of plankton growths, so frequently the cause of occasional unpleasant tastes in filtered water-supplies.

From what has been written, it will be appreciated that the present work provides yet another instance of the value of applying an empirical line of approach to a problem usually treated from an academic standpoint in which traditional practice exercises a weighty influence. Whilst the investigations were being pursued progress seemed slow and, at times, of negligible importance. However, in the final issue, the time devoted to experimental work proved to have been amply justified. No attempt has been made in this Paper to elaborate ancillary details connected with the precise manner in which water flows or floc is deposited in the circular clarifier. Any such digressions would be untimely in the present state of knowledge, and would be so obscured by hypothetical suppositions that the conclusions would be of little practical value. Full advantage is being taken of the laboratory facilities at hand to continue to study as exhaustively as possible all factors which may be contributing to, or detracting from, the general efficiency of the circular design, and when this investigatory work has reached a sufficiently advanced stage, it is hoped that it will be possible to make it the subject of a further publication.

The Paper is accompanied by three sheets of drawings and six photographs, from some of which the Figures in the text and the half-tone page-plate have been prepared.

TABLE III.—AVERAGES OF EXAMINATIONS OF HOURLY SAMPLES OF INFLUENT TO, AND EFFLUENT FROM, THE SIOUF CIRCULAR CLARIFIERS. (CLARIFIERS FIRST PUT INTO COMMISSION IN JUNE, 1935.)

		Albuminoid ammonia: parts per million.			Oxygen absorbed in 3 hours: parts per million.			Impurity figure*: parts per million.			Aluminium-sulphate dose.		Clarity: centimetres.		Suspended matter: parts per million.			Total dry silt removed†. tons.
		Influent.	Effluent.	Reduction: per cent.	Influent.	Effluent.	Reduction: per cent.	Influent.	Effluent.	Reduction: per cent.	Parts per million.	Grains per gallon.	Influent.	Effluent.	Influent.	Effluent.	Reduction: per cent.	
1935 Flood	Aug.–Oct.	—	—	—	—	—	—	—	—	—	37·2	2·6	2·6	48	335·2	25·8	92·3	609
Post-flood	Nov. & Dec.	0·2245	0·714	68·2	2·73	1·12	58·8	25·0	9·2	56·4	20·0	1·4	5·3	46	127·6	26·0	79·6	113
Annual average		0·254	0·082	67·7	3·11	1·15	63·1	28·2	9·8	64·7	25·1	1·76	6·5	47	336·4	22·4	93·4	722
1936 Pre-flood	Jan.–July	0·278	0·151	45·7	3·12	1·28	58·8	29·5	14·0	52·6	17·7	1·2	7·8	54	93·7	24·7	73·7	353
Flood	Aug.–Oct.	0·645	0·095	85·2	5·59	0·95	83·0	60·2	9·5	84·1	42·8	3·0	2·4	65	450·3	32·2	92·8	1,330
Post-flood	Nov. & Dec.	0·323	0·063	80·4	3·02	0·93	69·2	31·2	7·8	75·0	31·1	2·1	5·8	55	166·2	32·7	80·3	231
Annual average		0·377	0·122	67·6	3·81	1·14	70·0	37·9	11·8	68·9	26·2	1·83	6·1	57	301·4	27·9	90·7	1,914
1937 Pre-flood	Jan.–July	0·315	0·122	61·3	4·04	1·45	64·1	35·9	13·3	62·9	12·2	0·85	7·6	50	131·9	18·0	86·3	759
Flood	Aug.–Oct.	0·424	0·066	84·4	5·99	1·06	82·3	51·1	8·6	83·1	28·6	2·00	2·6	55	397·3	18·3	95·4	1,210
Post-flood	Nov. & Dec.	0·247	0·056	77·3	3·99	1·20	69·4	32·3	8·8	72·7	19·5	1·36	6·1	54	175·6	11·8	93·3	295
Annual average		0·315	0·097	69·2	4·24	1·31	69·1	36·9	11·4	69·1	17·5	1·22	6·1	52	289·2	17·2	94·0	2,264
1938 Pre-flood	Jan.–July	0·258	0·094	63·6	3·30	1·35	59·1	29·4	11·4	61·2	15·7	1·10	8·8	55	189·1	14·2	92·4	1,219
Flood	Aug.–Oct.[3]	0·450	0·070	84·5	7·36	1·12	84·8	59·3	9·1	84·6	35·8	2·50	2·5	57	704·7‡	23·1	96·7	2,199
Post-flood	Nov.–Dec.	0·242	0·022	90·9	4·71	1·02	78·4	35·6	6·2	82·6	17·9	1·25	3·6	50	301·0	22·0	92·7	506
Annual average		0·303	0·076	74·9	5·39	1·24	77·0	42·2	10·0	76·3	21·1	1·48	5·5	55	336·7	19·4	94·3	3,924
Average for years 1935–1938		0·312	0·094	69·9	4·14	1·21	70·8	36·3	10·7	70·4	22·5	1·58	6·0	53	315·9	21·7	93·3	Average per annum: 2,206 tons

* "Impurity figure" gives a measure of the organic matter contained in the samples. It is derived as follows:—(impurity figure) = $\frac{1}{2}$ {10 × (oxygen absorbed) + 100 × (albuminoid ammonia)}.

† In the last column figures are given for the total amounts of slurry removed from the clarifiers during the period indicated, as calculated from suspended matter estimations made on the influents and effluents. These figures are "dry weights." In actual operation this material is withdrawn from the clarifiers as a slurry containing only 10–13 per cent. "dry-weight" solid matter.

‡ During the worst 10 days of this period the average suspended matter in the raw water amounted to 891 parts per million. The corresponding figure for the clarified water was 20·4 parts per million, a reduction of 97·9 per cent.

[TABLE IV.

Paper No. 5215.

"The Determination of End-Constraint of Struts by Vibration Methods."

By Hugh Alan Warren, M.Sc. (Eng.), Assoc. M. Inst. C.E.

(*Ordered by the Council to be published with written discussion.*)[1]

TABLE OF CONTENTS.

Introduction.

Recent theory and design of struts, is related to the degree of end direction-constraint [2]. In this Paper the theory concerning transverse vibrations of struts [3] is modified and extended to conditions of elastic direction-constraint [4], and such theory is used as a basis for experimental work, demonstrating a means of evaluating elastic direction-constraint by measurement of the frequency of transverse vibrations when the axial load is known or can be measured.

Further calculations concerning the harmonics of the fundamental mode of vibration indicate how the same purpose might be achieved without a knowledge of the axial load.

Notation.

Let C_h denote the Euler critical load for a strut with hinged ends.
,, EI ,, flexural rigidity.

[1] Correspondence on this Paper can be accepted until the 15th March, 1940, and will be published in the Institution Journal for October, 1940.—Sec. Inst. C.E.

[2] Steel Structures Research Committee. Final Report, 1936. London.

[3] E. H. Bateman, "The Transverse Vibrations of a Simple Strut". Inst. C.E. Selected Engineering Paper No. 101, 1930.

[4] Professor R. V. Southwell, "An Introduction to the Theory of Elasticity", p. 215, Example 30. Oxford University Press, 1936.

Let g denote the acceleration due to gravity.
,, L ,, length of the strut.
,, M ,, elastic constraint due to vibration only.
,, n ,, frequency.
,, n_{ho} ,, frequency at zero load.
,, T ,, end load.
,, t ,, time.
,, w ,, weight per unit length.
,, α ,, angular velocity.
,, θ ,, slope at the end of the strut due to vibration only.

General Theory.

Frequency of Transverse Vibrations in a Strut having Elastically-Constrained Ends.

It has been shown [1] that, if a shaft of uniform cross-section is rotating, while subjected to an axial load and an unbalanced centrifugal force, the equilibrium (with respect to its distance from the axis) of an element of length is expressed by:

$$EI.\frac{d^4y}{dx^4} + T.\frac{d^2y}{dx^2} - \frac{W\alpha^2}{g}.y = 0. \quad \ldots \ldots \quad (1)$$

The solution [1] of equation (1) is:

$$y = A\sin\gamma_1 x + B\cos\gamma_1 x + C\sinh\gamma_2 x + D\cosh\gamma_2 x, \quad \ldots \quad (2)$$

in which A, B, C, D are arbitrary constants and γ_1, γ_2 are given by the equations:

$$\left.\begin{aligned} \gamma_1^2 &= \frac{T}{2EI} + \sqrt{\left(\frac{T}{2EI}\right)^2 + \frac{W\alpha^2}{gEI}} \\ \gamma_2^2 &= -\frac{T}{2EI} + \sqrt{\left(\frac{T}{2EI}\right)^2 + \frac{W\alpha^2}{gEI}} \end{aligned}\right\} \quad \ldots \ldots \quad (3)$$

A similar equation may be formed to apply to a strut of uniform cross-section. The motion of the element of length is now harmonic and equation (1) becomes:

$$EI.\frac{d^4y}{dx^4} + T.\frac{d^2y}{dx^2} + \frac{W}{g}.\frac{d^2y}{dt^2} = 0 \quad \ldots \ldots \quad (4)$$

The solution of equation (4) is:

$$y = (c_1\cosh Bx + c_2\sinh Bx + c_3\cos Ax + c_4\sin Ax)\cos pt, \qquad (5)$$

[1] E. H. Salmon, "Materials and Structures", vol. i, p. 323. Longmans, Green & Co., London, 1931.

in which c_1, c_2, c_3, c_4 are constants depending upon end-conditions, $p = 2\pi n$, and A and B are given by the following equations:

$$\frac{w}{g} \cdot \frac{1}{EI} \cdot p^2 = A^2B^2, \quad \ldots \ldots \quad (6)$$

and

$$\frac{T}{EI} = A^2 - B^2 \quad \ldots \ldots \quad (7)$$

(a) *Hinged Ends.*

For this well-known case, the result[1] of applying the conditions of hinged ends to equation (5) is:

$$n^2 = \frac{\pi^2 EIg}{4\,wL^4}\left(1 - \frac{TL^2}{\pi^2 EI}\right) \quad \ldots \ldots \quad (8)$$

Equation (8) may be simplified by writing C_h in place of $\frac{\pi^2 EI}{L^2}$ (Euler's load). Further, if n_{ho} is the frequency of vibration when the load is zero, then:

$$n^2{}_{ho} = \frac{\pi^2 EIg}{4wL^4} \quad \ldots \ldots \quad (9)$$

and equation (8) becomes:

$$\left(\frac{n}{n_{ho}}\right)^2 = 1 - \frac{T}{C_h} \quad \ldots \ldots \quad (10)$$

Fig. 2 (p. 54, *post*) shows the relationship between $\frac{n}{n_{ho}}$ and $\frac{T}{C_h}$ for various types of end-fixing. The inner curve, marked " $N = \infty$ (hinged) ", is derived from equation (10), N being a constant which may conveniently be referred to as the " modulus of end-fixity ".

(b) *Ends Elastically Constrained.*

If the degree of constraint is the same at each end, the origin of co-ordinates may be taken to be at the mid-point of the length (*Figs. 1*, p. 52). In this case:

$$\frac{dy}{dx} = \frac{d^3y}{dx^3} = 0 \qquad \text{when } x = 0,$$

and

$$y = 0 \qquad \text{when } x = \pm\frac{L}{2},$$

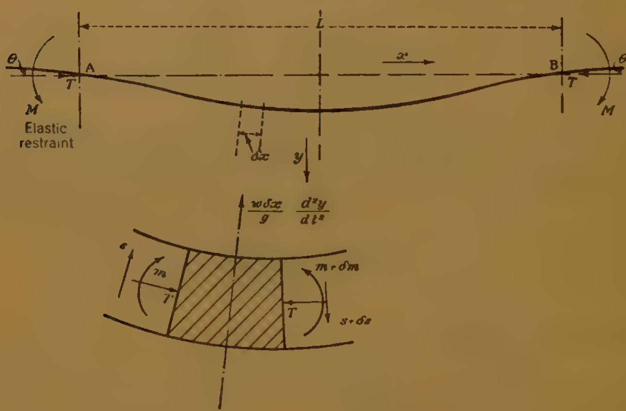
[1] Professor S. Timoshenko, "Vibration Problems in Engineering", p. 342. Constable & Company, Ltd., London, 1937.

upon application of which, equation (5) becomes :

$$y = c_5 \left(\frac{\cosh Bx}{\cosh \frac{BL}{2}} - \frac{\cos Ax}{\cos \frac{AL}{2}} \right) \cos pt \quad . \quad . \quad . \quad (11)$$

It is convenient to adopt the ratio $\frac{\theta}{M}$ as a measure of the end-constraint. This ratio may be written μ and called the " degree of end-fixity ".

Figs. 1.



A further salient condition is :

$$\mu = \frac{-\frac{dy}{dx}}{EI.\frac{d^2y}{dx^2}}, \qquad \text{when } x = \frac{L}{2}.$$

If this condition is applied to equation (11) the result may be simplified to :

$$\frac{\mu EI}{L} = \frac{B_1 \tanh B_1 + A_1 \tan A_1}{-(2B_1^2 + 2A_1^2)} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

where $\qquad B_1 = \frac{BL}{2}$ and $A_1 = \frac{AL}{2}$.

$\frac{\mu EI}{L}$ is the fraction which has been replaced by N in the foregoing

theory and is referred to as the "modulus of end-fixity". Equation (12) now becomes:

$$B_1 \tanh B_1 + A_1 \tan A_1 + 2N(B_1^2 + A_1^2) = 0 \quad . \quad . \quad (13)$$

For any chosen value of N, equation (13) provides corresponding values of A_1 and B_1. Substitution of these values of A_1 and B_1 in equations (6) and (7) allows determination of values of p and T. It is more convenient, however, for purposes of calculation and plotting, to obtain $\frac{n}{n_{ho}}$ and $\frac{T}{C_h}$. Then, dividing the left-hand side of equation (6) by the left-hand side of equation (9), and the right-hand side of equation (6) by the right-hand side of equation (9), the resulting equation may be simplified to:

$$\frac{n}{n_{ho}} = \frac{4A_1B_1}{\pi^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

In the same way, dividing the left-hand side of equation (7) by C_h, and the right-hand side by $\frac{\pi^2 EI}{L}$, the resulting equation may be simplified to:

$$\frac{T}{C_h} = \frac{4(A_1^2 - B_1^2)}{\pi^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

From equations (14) and (15) the desired values may readily be calculated. The numerical results of such calculations, for a value of $N = 0{\cdot}136$, are shown in Table I and plotted in *Fig. 2*, p. 54.

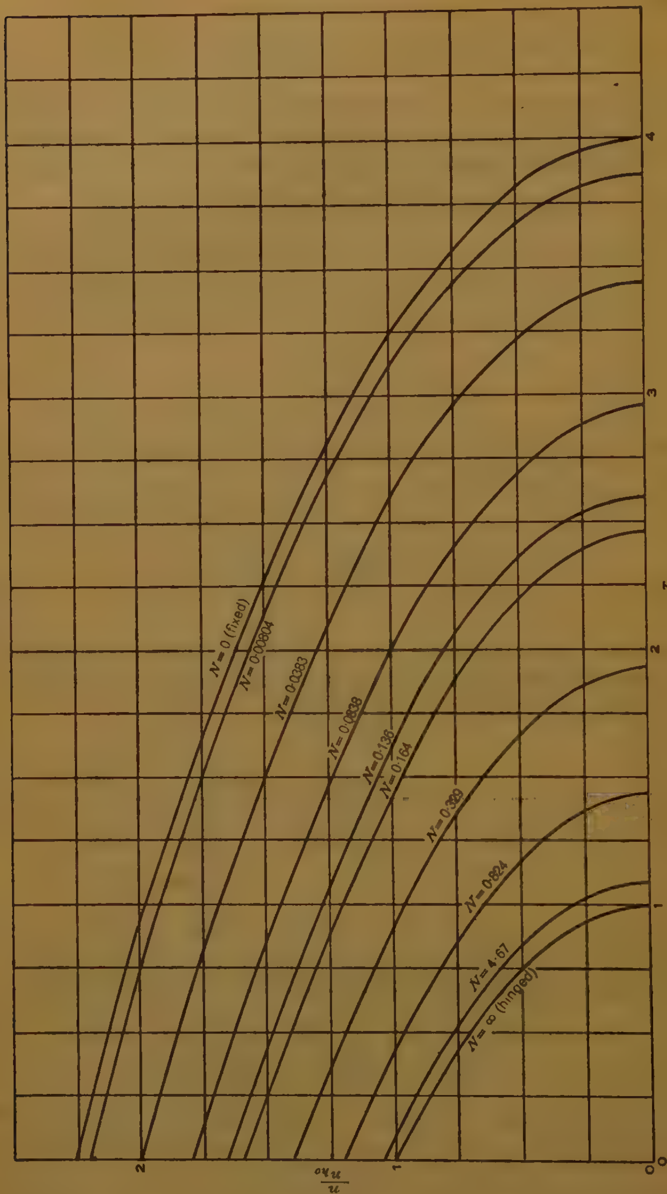
TABLE I.

$\frac{T}{C_h}$	0·00	0·065	0·270	0·497	0·714	0·916	1·13
$\frac{n}{n_{ho}}$	1·67	1·63	1·55	1·48	1·39	1·32	1·21

$\frac{T}{C_h}$	1·33	1·56	1·78	1·99	2·19	2·40	2·60
$\frac{n}{n_{ho}}$	1·12	1·02	0·930	0·796	0·656	0·470	0·00

The process of computation is long and tedious, but the curves in *Fig. 2*, other than that for $N = 0{\cdot}136$, may be interpolated with sufficient accuracy after calculating their "terminal points". The expression "terminal

Fig. 2.



CALCULATED CURVES.

points" refers to the value of $\frac{n}{n_{ho}}$ for zero load (in which case $A_1 = B_1$) and the value of $\frac{T}{C_h}$ for zero frequency (in which case $B_1 = 0$).

For zero load, equation (13) simplifies to :

$$\tan B_1 + \tanh B_1 + 4B_1N = 0, \quad . \quad . \quad . \quad . \quad . \quad (16)$$

and equation (14) becomes :

$$\frac{n}{n_{ho}} = \frac{4B_1{}^2}{\pi^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

For zero frequency, equation (13) simplies to [1] :

$$\tan A_1 + 2A_1N = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

and equation (15) becomes :

$$\frac{T}{C_h} = \frac{4A_1{}^2}{\pi^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

For any value of N, values of $\frac{n}{n_{ho}}$ may be found from equations (16) and (17), and values of $\frac{T}{C_n}$ from equations (18) and (19). Values of $\frac{n}{n_{ho}}$ and $\frac{T}{C_h}$ have been calculated for various values of N and the results are shown in Table II and *Fig. 2.*

TABLE II.

N	4·67	0·824	0·329	0·164	0·0838	0·0383	0·00804
$\frac{n}{n_{ho}}$	1·04	1·20	1·40	1·60	1·80	2·00	2·20
$\frac{T}{C_h}$	1·085	1·43	1·93	2·46	2·96	3·44	3·86

(c) *Fixed Ends.*

For ends having absolute direction-fixing $\mu = 0 = N$ (by definition), and equation (13) reduces to :

$$B_1 \tanh B_1 + A_1 \tan A_1 = 0 \quad . \quad . \quad . \quad . \quad (20)$$

[1] Professor S. Timoshenko, "Theory of Elastic Stability," p. 91, equation 68. McGraw-Hill Book Company, Inc., New York, 1936.

Corresponding values of $\frac{T}{C_h}$ and $\frac{n}{n_{ho}}$ may be calculated as before, and are shown in Table III and *Fig. 2.*

TABLE III.

$\frac{T}{C_h}$	0·00	0·411	0·874	1·350	1·762	2·184	2·588
$\frac{n}{n_{ho}}$	2·26	2·15	2·02	1·854	1·709	1·538	1·361

$\frac{T}{C_h}$	2·960	3·280	3·580	3·820	3·900	4·00
$\frac{n}{n_{ho}}$	1·170	0·962	0·740	0·502	0·379	0·00

Analyses such as the above have been made for other forms of end-constraint, including :

(*a*) one end hinged, other end elastically-constrained,
(*b*) semi-circular ends,
and (*c*) ends having unequal degrees of elastic constraint.

These analyses are not reproduced in this Paper, but the theory set out in the foregoing pages indicates, sufficiently, the methods adopted.

CRITICAL LOAD AND EFFECTIVE LENGTH-RATIO FOR DESIGN.

The load at which $n = 0$ is the Euler critical load and, when applied to a strut with hinged ends is denoted by C_h. If C denotes the critical load for a strut with constrained ends, then, for any fixed value of N, equation (19) gives :

$$\frac{C}{C_h} = \frac{4A_1^2}{\pi^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

If qL represents the effective length of the strut with constrained ends

then : $$C = \frac{\pi^2 E.I.}{(qL)^2}.$$

But $$C_h = \frac{\pi^2 E.I.}{L^2};$$

hence $$\frac{1}{q^2} = \frac{C}{C_h} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

From equations (21) and (22) it can easily be shown that:

$$A_1 = \frac{\pi}{2q}.$$

Substituting for A_1, equation (18) becomes

$$\tan\left(\frac{\pi}{2q}\right) + \frac{\pi N}{q} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

which gives a relationship between N and q.

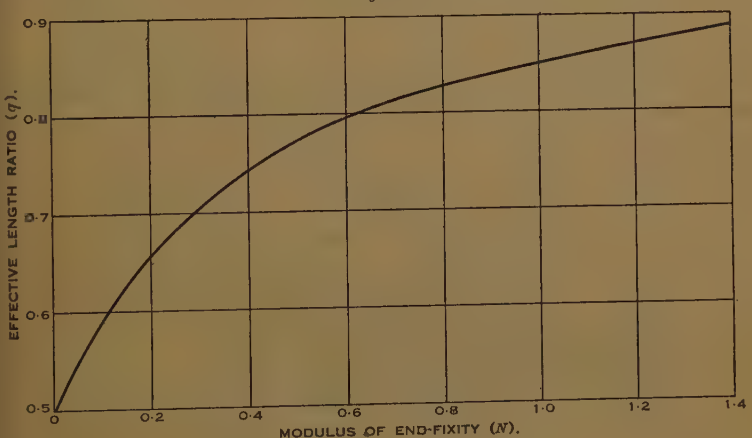
It will be shown that N can be determined experimentally, and so equation (23) establishes a method of finding q. This is important, since, at present, q is arbitrarily assumed for design purposes.

Corresponding values of N and q are shown in Table IV and plotted in *Fig. 3*.

TABLE IV.

N	∞	1·624	0·716	0·414	0·262	0·172	0·110	0·065	0·0297	0·000
q	1·00	0·905	0·817	0·750	0·690	0·641	0·599	0·561	0·528	0·500

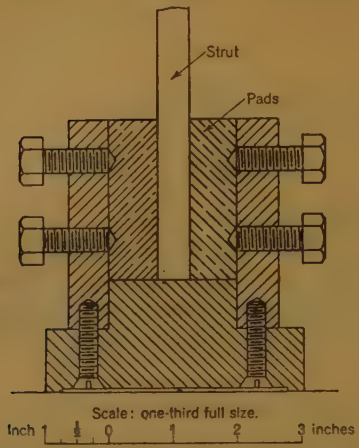
Fig. 3.



EXPERIMENTAL WORK.

The struts used were of rectangular cross-section, the ends being constrained in direction by grips (*Fig. 4*, p. 58) which were sufficiently massive to ensure that there was complete fixity of position. The apparatus (*Fig. 5*, p. 58) for measuring the frequency of transverse vibration was simple but effective, and reasonably accurate. The vibration of the steel strut A induced a corresponding current in the electro-magnets B, which caused an audible note in a pair of headphones. The frequency of this

Fig. 4.



note was measured by comparison with an exactly-tuned sonometer wire itself standardized by tuning-forks. The electro-magnets B could, by means of the micrometer screws C, be brought as close as possible to the strut without contact, thus increasing the strength of the note heard. Vibration of the strut was effected by a sharp tap near the centre of its length.

Table V shows the sizes and other properties of the four struts tested in the above manner, the two latter columns having been calculated from formulas (8) and (10) for hinged ends.

Fig. 5.

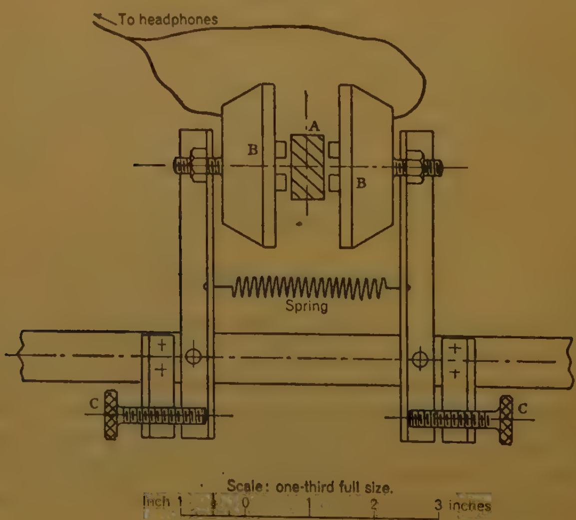
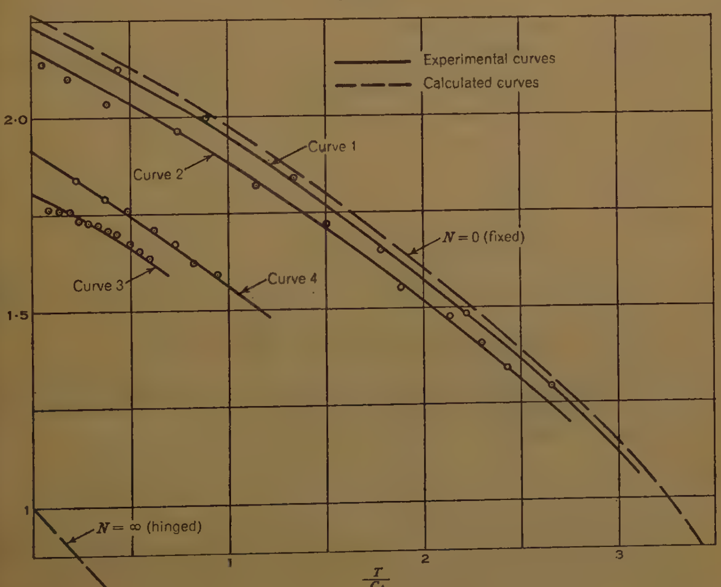


TABLE V.

No.	Section: (inches) × (inches.)	Length: inches.	(Length) ÷ (least radius of gyration.)	C_h: lb.	n_{ho}: vibrations per second.
1	$1 \times \frac{3}{16}$	12	221	1,125	119
2	$1 \times \frac{1}{4}$	12	166	2,675	159
3	$1 \times \frac{1}{2}$	12	83	21,350	318
4	$1 \times \frac{1}{2}$	18	125	9,500	141

xperimental observations of frequency at various loads were converted values of $\frac{n}{n_{ho}}$ and $\frac{T}{C_h}$ respectively, and plotted (*Fig. 6*). It was impossible measure frequency at zero load as the grips would not have remained rm on their seatings in the testing machine, but from the plotted curves, hich will be seen to agree closely in shape with those calculated (*Fig. 2*), e value of $\frac{n}{n_{ho}}$ at zero load can be read off, within small limits, by extra-

Fig. 6.



olation. Thence by equations (16) and (17), N can be found, and further, y equation (23), the value of q calculated. The actual degree of endxity, μ, afforded by the grips will be found from $\mu = \frac{LN}{EI}$. These results re presented in Table VI (p. 60).

TABLE VI.

No.	Section: (inches) × (inches).	Length: inches.	$\frac{n}{n_{ho}}$.	N.	q.	$\mu \times 10^6$, radius per lb.-inch.
1	$1 \times \frac{3}{16}$	12	2·24	0·0049	0·505	3·57
2	$1 \times \frac{1}{4}$	12	2·14	0·0105	0·510	3·24
3	$1 \times \frac{1}{2}$	12	1·81	0·0820	0·580	3·14
4	$1 \times \frac{1}{2}$	18	1·91	0·0537	0·552	3·10

It may be concluded, from the similarity in shape between the theoretical and experimental curves, and the fairly consistent values of μ obtained, that the method described is a satisfactory means of determining end-fixity.

Harmonics.

In the experimental method just described the load was measured; but in many practical cases this would be difficult or impossible, since the strut may exist as part of a structure and may be carrying an unknown amount of dead load. This difficulty, however, may be surmounted by making use of the harmonic frequencies.

In equation (5), which is quite general for all modes of vibration, the following sets of conditions must be satisfied :

(*a*) $x = \pm \frac{L}{2}, y = 0.$

(*b*) $x = \pm \frac{L}{2}, \frac{\text{slope}}{\text{moment}} = \mu.$

(*c*) $x = 0, \frac{dy}{dx} = 0$ (first, third, etc. modes of vibration).

(*d*) $x = 0, y = 0$ (second, fourth, etc. modes of vibration).

From the above conditions may be derived the following equations :

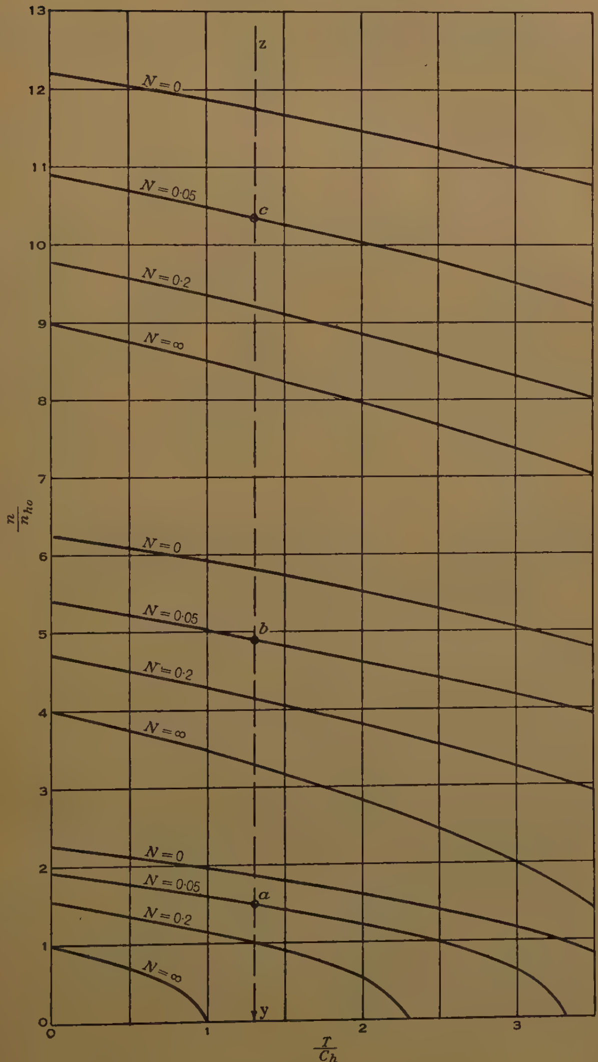
$$A_1 \tan A_1 + B_1 \tanh B_1 + 2N(A_1^2 + B_1^2) = 0 \text{ (first, third, etc.)} \quad . \quad (24)$$

$$A_1 \cot A_1 - B_1 \coth B_1 - 2N(A_1^2 - B_1^2) = 0 \text{ (second, fourth, etc.)} \quad (25)$$

From equations (24) and (25), values of $\frac{n}{n_{ho}}$ and $\frac{T}{C_h}$ may be calculated enabling the curves shown in *Fig.* 7 to be plotted. Inspection will show that if *a*, *b*, *c* be three frequencies, experimentally observed, for the fundamental and two harmonics, then there will be a unique solution for the position of the line *yz*, since the value of N must be the same for each of *a*, *b*, *c*. This renders a knowledge of the load unnecessary. Two points, *a* and *b*, would be sufficient, but a third point *c* affords a check.

If the ends of the strut have unequal degrees of fixity the above curves

Fig. 7.



HARMONIC CURVES.

will not apply, but upon substitution of the particular conditions of an case in the general equation, relations may be established from which the appropriate family of curves may be plotted.

The Paper is accompanied by seven sheets of drawings, from which the Figures in the text have been prepared.

ASSOCIATION OF LONDON STUDENTS.

ADDRESS OF

ERIC WILLIAM CUTHBERT, M.Sc. (Eng.), Stud. Inst. C.E.,

CHAIRMAN OF THE ASSOCIATION, 1939–40.

writing these notes of the Address which should have been given at the pening meeting of the 1939–40 Session, I regret that the Chairman's aditional appeal to members of the Association to support forthcoming tivities is not now required. Whilst we cannot look forward to our sual programme of meetings, visits, and social functions, we may remember ith pleasure our successes of past years. The friendships made and newed at meetings, the instructive Papers, followed by spirited discussions, nd the enjoyable dances and dinners, have left memories to be cherished ntil we may once again enjoy to the full the benefits bestowed on members f the Association.

Since my predecessor submitted his Annual Report for the 1938–39 ession, the annual competition for the Trophy presented by Mr. H. T. oung, Past-President of the Institution of Electrical Engineers, has been ecided. After some enjoyable contests, the Association succeeded in efeating the London Students and Graduates of the Institution of echanical Engineers for second place, the kindred association of the nstitution of Electrical Engineers being the winners.

As the subject for the technical part of my Address I had chosen The Development of London's Underground Railway System, with articular reference to the Northern Electrification." Owing to circumstances over which I have little control these notes must concern the istoric, rather than the prophetic, aspect of development.

The earliest underground railway lines to be built in London were not ne comparatively deep lines known familiarly as "tubes." In 1853 the rst section of the Metropolitan Railway was begun, and the Metropolitan istrict Railway followed soon after. The tunnels were built on the cut-and-cover" principle, for the most part along the line of streets, his method entailing the closing of whole sections of road during the onstruction in trench of the brick tunnels, the crown of which was only few feet below carriageway-level. Where it was not possible to follow oads, properties had to be underpinned, or acquired and demolished. he confusion and dislocation of traffic while works were in progress can e imagined. Expensive diversions of services, particularly sewers, were ecessary, and in some cases, as at Sloane Square station where the Rane-

lagh sewer crosses the line, bridges had to be built to carry them on the original line. These early underground lines were operated by steam locomotives until early in the present century, and in spite of the ventilators which were built at intervals along the route conditions for passengers and staff must have been almost unbearable.

With the advent of electric traction deep-level tunnels became possible for railways, whilst the shield evolved by Greathead for the construction of the Tower subway had made tunnelling, even in difficult ground, a comparatively safe and practical operation. The advantages of tunnelling at depths of up to 100 feet below ground-level were many in a city like London. Foundations of buildings and services were not affected, and street traffic was not hampered during construction, the only disturbance to the ground surface being at working shafts, which often became the sites of upper stations, electricity sub-stations, or ventilation stations.

In 1890 the first section of the City and South London Railway was opened between Stockwell and King William Street in the City. The tunnel lining consisted of cast-iron segments bolted together to form rings of 10 feet 2 inches internal diameter. Following the City and South London Line came the Central London Railway, or "Tuppenny Tube", with tunnels 11 feet 8¼ inches in diameter, and in the next few years the "Bakerloo", Piccadilly, and Great Northern and City lines were built. The last-named was the only "tube" line built large enough to accommodate main-line rolling stock. Whilst the ordinary type of Greathead shield was used generally, on certain sections of line a shield with a rotary cutter was employed.

Most of the original tube lines were constructed for traffic across the Metropolis, the suburban branches of the main-line companies still carrying most of the business traffic. With the introduction of mechanically propelled public-service vehicles, the underground railways could no longer show a saving of time on short journeys, which involved the delay at either end due to travelling in lifts giving only an intermittent service. In order to succeed, underground railways required, and still require, a density of traffic far in excess of that required for surface lines, by reason of the enormous capital outlay involved. Two ways of attracting traffic were adopted, and have been consistently followed.

The first method was to extend the original lines radially towards the country in tunnel, until the reduced intensity of building and other development allowed them to reach the surface. They were then continued on the surface into the suburbs. By offering direct West-End or City connexion without the inconvenience of changes at main-line termini, the underground railways encouraged the rapid acceleration of the exodus, the end of which is not yet in sight, from the central areas towards the country. Thus, every Londoner to-day makes four times as many journeys by underground than he did 30 years ago, and the average fare paid has gradually increased. Examples of the radial growth are well known to a

ut the City and South London Railway affords one of the best. The rst extensions were from Borough to Moorgate in the north, and from tockwell to Clapham Common in the south in 1900. In 1907 the northern rminus was Euston, and in the same year the Golders Green and ighgate Line was opened with the southern terminus at the Strand. The vo lines were linked between Euston and Camden Town in 1924, when the olders Green branch was extended to Edgware. Two years later the uthern end was extended from Clapham Common to Morden, at the ime time as the link between Strand and Kennington was constructed. uring 1924 the City and South London section was closed, while the old)-feet 2-inch tunnels were enlarged to the standard diameter for the nderground railway.

The second way by which traffic has been attracted has been the im- rovement of facilities for dealing with passengers in the central area. ifts have been replaced by escalators at most important stations. Inter- hange between lines, which suffered in the early days through competition nd lack of planning, has been improved. Badly-sited stations have been osed in order to speed up services, whilst certain new stations have been uilt in more suitable positions. More attention has been given to assenger comfort.

The 1935–40 New Works Programme continues the quest for more affic by the extension of existing lines, whilst the improvement in the entral areas proceeds. Where possible, the tube lines, on reaching the urface, are being projected over branches at present operated by the main- ne companies. These lines are being electrified and resignalled for more equent services, whilst the stations are in many cases being rebuilt. he Northern Electrification scheme for the London and North Eastern ailway Company's High Barnet branch is one of these, and is being carried ut in conjunction with the extensions of the Northern Line, the present ame for the Edgware–Morden system. Secondary branches of the igh Barnet branch have termini at Alexandra Palace and Edgware espectively, the latter being close to the Northern Line terminus.

The works involved in the Northern Electrification include the physical onnexion of the Northern Line and the L.N.E.R. branch at Edgware, nd the widening of the latter from single to double line, the construction of win tube tunnels from Highgate (Northern Line) to connect with the igh Barnet branch at East Finchley, and the construction of inclines to onnect the High Barnet branch lines at Finsbury Park with the tube- ne tunnels at Drayton Park. The effect on traffic in North London will e appreciated by reference to a railway map. A direct West-End con- exion is to be provided for an area which had steam-line connexions to ing's Cross and the City, whilst another route to the City is provided for assengers from the Edgware district. In this way the overcrowded dgware branch of the Northern Line should be relieved.

In addition to the construction of the three links between the existing

underground system and the lines to be electrified, an extension fro Edgware to Busheyheath, known as the Elstree Extension, was begu this year. This would continue the radial growth towards the countr but the extension is also required as a connexion to a new rolling-stoc depôt to be constructed at Elstree, owing to the existing Northern Lin depôt at Golders Green being inadequate to deal with the stock to b operated over the electrified lines.

It had been my intention to deal in some detail with the works involve in the Elstree Extension, but recent events have made it necessary for th work to be suspended.

"Hall of Metals."

New York World's Fair, 1939.

By Brian Maude Bellasis.

r was no easy matter to devise a means whereby a survey of the industrial restige of Great Britain could be compressed into a hall with an area of),000 square feet in the United Kingdom pavilion at the New York World's air. The problem was solved by taking as a "theme" the fact that all ndustrial progress rested upon advancement in the production of iron and teel, and, further, on the very interesting fact that each successive forward tep had been the result of British invention.

The central feature of the hall, therefore, was a huge hexagonal display, ach face showing in a simple and graphic manner one of the steps forward n development from the primitive charcoal-smelted iron of Sussex to he complex alloy steels of to-day. The six panels showed:

(1) Sussex iron, 1650. This panel included a reproduction of a very quaint clock-face of that date, which showed all the processes of iron-winning and working as then known.
(2) Coal smelting, by Abraham Darby (1711–1763).
(3) Rolling mill, by Henry Cort (1740–1800).
(4) Hot-blast iron, by James Neilson (1792–1865).
(5) Bessemer steel, by Henry Bessemer (1813–1898).
(6) Alloy steels, by Michael Faraday (1791–1867), Robert Mushet (1811–1891), and Robert Hadfield (1858).

Stainless steel was shown in an individual exhibit.

It is difficult to describe those panels without the aid of photographs, but the contribution to world progress made by each particular invention was made manifest, partly by portrait plaques of the inventors, partly by pictures and dioramas, and partly by the application on the panel of actual rticles such as drills, tools, and samples. In one corner of each panel its tory was briefly summarized in written form. Not only was it thus quite easily followed by uninstructed members of the public, but it was found that very often it gave the technician an insight into aspects of progress which, through his closeness to the technical picture, he had previously failed to ppreciate.

A considerable amount of research was required in making up those panels and a large number of authorities were consulted, including many members of The Institution. The principal help, both technical and financial, came from the Iron & Steel Federation.

The remainder of the hall contained about fifteen separate exhibits, a having some bearing on the central "theme." The most prominent an popular object was probably Captain G. E. T. Eyston's record-breaking c *Thunderbolt*, which, naturally, attracted particular attention from a publ so motor-car-minded as that of America. Ranged around the walls of th hall, and in certain island positions, were exhibits which included a com plete motor car, together with its component parts, a number of interestin examples showing the hardness, tensile strength, and other properties certain alloy steels; there were, in fact, a variety of exhibits which we given a special meaning through their relationship to the central hexago

Stress was laid on the fact—quickly appreciated by the mechanicall minded American—that human ingenuity was not itself a "modern inven tion", but was merely released from trammels and inhibitions by th provision of better material. The exhibit arranged by the cycle trades, fo example, quite obviously demonstrated that the first pedal cycle of 10 years ago—which was lent by the Science Museum—was the best that th inventor could produce with only the blacksmith and the coachbuilder t help him. The modern cycles and motor cycles at the other end of the sca could not come into being until various qualities of steel and of alloys ha been discovered and put at the inventor's service. The argument wa strengthened by the inclusion of a very interesting show of old Sussex-iro fireplace furniture, which included many crude but most ingenious labou saving devices.

Similarly, a section of a tramway crossing made of manganese steel wa shown and the practical value of hard alloys was demonstrated in an easil understood manner by the comparative lack of wear shown by the crossing although some millions of tramcars had used it.

There were numerous other exhibits, all of which were selected with th object of showing the perfection of workmanship made possible by th quality of modern materials. One exhibit, for example, included th smallest stainless-steel tube in the world, which can be seen only through magnifying glass, and which was compared with a human hair. Thi exhibit seemed of particular interest to Americans, as illustrating in concentrated form the quality of fine and delicate workmanship which wa observable in many other exhibits. This was considered a particularl British characteristic, and was the subject of most frequent remark fro members of the public.

From the propaganda point of view it is probable that the most lastin impression left by the "Hall of Metals" on the minds of the public will be th capacity of British manufacturers for turning out delicate and beautifully finished products. This quality was also evidenced in two ship's propeller which were really beautiful as well as interesting objects. They also serve to point the moral that, although space in the hall was sufficient only t deal in any detail with iron and steel, the same process of development ha been taking place in non-ferrous metals.

Other displays of a popular character illustrated the efficiency of a
ıagnetic alloy, and of the new heavy alloy which has nearly twice the pecific gravity of lead. This alloy, which was originally produced to rovide effective protection for radium in hospital use, is now being turned o a number of industrial purposes.

A very interesting exhibit arranged by the electrical industries showed he development of the turbine, the original Parsons turbine being shown ide by side with examples of the enormous variety of turbine-blades which ave been evolved in the development or extension of Parsons's original rinciple.

One end of the hall departed from the strict metallurgical character of he display by accommodating an exhibit of optical and scientific instrunents. These were included, partly because they had a certain relationhip to the "theme", since research would be impossible without them, nd partly because the capability of British manufacturers of these articles s to a great extent unknown in the United States, and needed stressing. 'he Germans and the Americans themselves commonly get credit for being ar ahead of the British, especially in the production of optical instruments. 'he greatest astonishment was expressed by visitors on learning, for xample, that practically all the lenses used in Hollywood are of British roduction, and, indeed, that for nearly all really fine and accurate enses recourse has to be made to England rather than to any other ountry.

For the first time an attempt was made to arrange a display of these nanufactures in a manner which would give the general public an idea of ıow they contributed to everyday life and progress. As a central feature vas shown an enormous mass of rough optical glass just as it came from the rucible. With a suitable background and lighting this was a really beautiful object, and both attracted attention and enlisted inquiry into he use and purpose of the objects of which it formed the focal point. Partly by two very large groups of mural photographs, and partly by an ngenious sequence of show-cases, the public were given an idea of the use of various instruments, from the spectacles and field-glasses with which hey were familiar, as contributing to the comfort and efficiency of their own eyesight, to microbalances, spectrographs, and other instruments which the scientist and technician used in work beyond the knowledge of he ordinary general public.

Altogether the hall was of a nature to be easily understood by nonechnical persons, whilst not seeming merely childish to the technical visitor. Above all the hall did not attempt to say or show too much. Its story was easily grasped; there were enough exhibits to be various and nteresting without producing any mental indigestion.

In addition to admiration of the fineness of the workmanship, Americans also appreciated the fact that exhibits were not arranged in any boastful spirit, but with the implication that, while Great Britain could be proud of

initiating all the leading forward steps in the progress of metallurgy, th fact was recognized that America itself, and in fact the whole world, wa taking part in its continuous development.

The World's Fair closed on October 31st. It is announced that it w be continued for a second year, but the British pavilion will not be carrie on, nor is it expected that many foreign nations will remain for a secon year.

THE LATE DR. J. H. T. TUDSBERY.

SECRETARY OF THE INSTITUTION 1896-1922.

OBITUARY.

JOHN HENRY TUDSBERY TUDSBERY, D.Sc., the son of /illiam Tudsbery Turner (he assumed the patronymic Tudsbery by royal cence in 1894), was born at Storeton (near Birkenhead), Cheshire, on the st October, 1859, and died at Emsworth, Hampshire, on the 10th October, 939. He was educated at the Birkenhead School, and later graduated at lasgow University, of which he was a Hunter Medallist, and where he btained the degree of D.Sc. On leaving the University, he was articled the late Dr. G. F. Deacon, M. Inst. C.E., and after spending a short time Barrow Steel and Iron Works in the study of mechanical engineering, he ecame, in 1881, Dr. Deacon's assistant on the Vyrnwy Waterworks scheme the Liverpool Corporation. In 1885 he entered the service of the apanese Imperial Government, and was engaged on the construction of aterworks and other engineering undertakings, including the water-supply Yokohama. From 1887 until 1892 he was in private practice in Liverbol, and in addition to hydraulic schemes and other engineering works, e carried out the first engineering survey of the Mersey estuary. During his period he became Honorary Secretary of the Liverpool Engineering ociety.

In 1892 he was appointed Assistant Secretary of the Institution of ivil Engineers, and moved to London to take up his duties; in 1896 he acceeded Mr. James Forrest as Secretary, which position he retained until e retired early in 1922. His appointment as Secretary was almost multaneous with the decision to set up a system of examinations for entry ito The Institution, with the object of ensuring that candidates possessed dequate general education and scientific knowledge, and he contributed a rge share to the development of the examination system. He was also oncerned in the various steps leading to more rigid definitions of the onditions of training necessary for young men desirous of becoming ngineers. During his secretaryship he had to supervise the removal of he Institution to its present building, and upon him devolved the organizaon of four Engineering Conferences in 1897, 1899, 1907, and 1921, as well s of the Conference on the Education and Training of Engineers which was eld in The Institution in 1911. Upon him also fell the task of organization hen The Institution invited members of the American Society of Civil ngineers to visit Great Britain in 1900. He undertook subsequently the rrangements for the return visit of The Institution to New York as guests f the American Society and of the Canadian Society of Civil Engineers how the Engineering Institute of Canada), the tour including a visit to t. Louis at the invitation of the American Society, who had organized an

International Engineering Congress in connexion with the great Expositio held there. In performing such duties Dr. Tudsbery imparted grea impetus to the establishment of friendly relations between the engineers Great Britain and those of the North American continent.

To commemorate the centenary of the founding of The Institution, o the 2nd January, 1818, he prepared a record of its origin and progres which he presented to the members at a meeting of The Institution on th 8th January, 1918 *. He did much to maintain the already high standin of The Institution, and to further its essential aims as defined in its Roya Charters, and during his term of office his organizing ability found full scop in regard to the putting into practice of important changes made by th Council affecting policy and administration. On his retirement from th secretaryship in 1922 he was appointed Honorary Secretary, a position tha he held until his death.

In 1885 he presented to The Institution a Paper entitled "The Gaugin of Flowing Water" †, for which he was awarded a Miller Prize, and late he presented two other Papers ‡. He was also joint author, wit Dr. A. W. Brightmore, M. Inst. C.E., of the well-known work "Th Principles of Water-Works Engineering", of which three editions wer published, the last in 1905. He was admitted to The Institution as Student in 1877, and was elected an Associate Member in 1885, bein transferred to the class of Member in 1892. He was a Past-President o the Smeatonian Society of Civil Engineers, and was an Honorary Membe of the Institution of Royal Engineers, of the Koninklijk Instituut va Ingenieurs, Holland, and of the Liverpool Engineering Society.

In 1885 he married Roberta Emeline, daughter of John McMurd Cannon, of Liverpool; she died in 1935. There were four sons and on daughter. Two of his sons are engineers and Members of The Institutio and one was called to the Bar in 1911; the youngest son, a Student of Th Institution, lost his life during the war of 1914–18.

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* Minutes of Proceedings Inst. C.E., vol. ccv (1917–18, Part I), p. 216.

† *Ibid.*, vol. lxxx (1884–85, Part II), p. 318.

‡ "Notes upon Useful Japanese Timber." *Ibid.*, vol. lxxxix (1886–87, Part III p. 417.

"The Construction of the Yokohama Water-Works." *Ibid.*, vol. c (1889–90, Par II), p. 277.

ABSTRACTS OF THE CURRENT TECHNICAL LITERATURE OF ENGINEERING AND APPLIED SCIENCE.

NOVEMBER, 1939.

ENGINEERING CONSTRUCTION.

A Mobile Seismic Recording Unit. F. M. G. Murphy, S. T. Cope, nd J. H. Jones (**Phil. Mag.*, 28, *370–380 ; Sept. 1939*).—The Authors bserve that the rapid increase in the number of proved oil-fields is due rgely to the efficiency of modern geophysical surveys. The detectors nd recording apparatus described are suitable for both reflexion and efraction surveys. Six detectors are normally used, spaced at intervals f 150 feet and at a mean distance of 2,000 feet from the explosion-point. he recording unit occupies the mid-position of the instrument-spread, nd telephonic or radio communication is established between the unit nd the firing-station. The Authors discuss the theory of the method, escribe in detail the apparatus and its arrangement in a 30-cwt. van, nd reproduce typical seismograms.

Pile Foundations. C. Cestelli (**Ann. Lav. Pubbl.*, 77, *676–684 ; uly 1939*).—The Author discusses the design of piled foundations, with articular regard to the relations which connect the stability of a single pile ith that of a group of piles taken as a whole. He presents the results of ests made on a typical pile during driving.

Field Tests on a Shale Foundation. A. E. Niederhoff (**J. mer. Soc. Civ. Engrs.*, 65, *1239–1254 ; Sept. 1939*).—The tests described ere made on the foundation of the Possum Kingdom dam, Texas (Engng. bstracts, 2 (*Con.*) No. 187 ; *Aug. 1939*). They included time–settlement ests on square plates of various sizes, a cyclic loading test, and tests to scertain the effect of bond and coefficient of friction of concrete monoliths n a prepared shale foundation. The results are analysed in the light of he current theories on soil mechanics, and are compared with those btained from laboratory tests on smaller specimens. The Author derives ormulas and suggests permissible load values for shale as a foundation naterial.

Notes.—An asterisk prefixed to a reference, thus **Phil. Mag.*, denotes that the rticle is illustrated.

The abbreviated titles of periodicals are those used in the "World List of Scientific eriodicals." (Oxford 1934.)

Shaft-sinking on the Delaware River Aqueduct. (**Engng. News-Rec.*, 123, *233–237 ; 17 Aug. 1939.*)—Modern shaft-sinking practice exemplified in the construction of twenty-three shafts, aggregating 15,000 feet in depth, as part of the New York City water-supply system. The shafts were sunk to various depths in differing types of ground and under surface conditions varying from residential areas to wild mountainous country. The drilling, excavation, and concrete-lining operations at one of the shafts are described in detail. The total contract price amounted to more than $10,000,000.

Water-Pressure Indicators for use in Earth Dams. D. R. MA… (**Engng. News-Rec.*, 123, *212–213 ; 17 Aug. 1939*).—In order to obtain continuous and accurate information concerning percolation in large earth dams, the U.S. Bureau of Reclamation has installed diaphragm-type hydrostatic pressure-indicators. Each indicator measures the pressure of the percolating water at one point in the dam, and from these measurements the saturation (zero-pressure) line, the stream-lines, and the frictional forces of the flow are derived. The indicators are 1 inch diameter and 2 inches long, and have gold-plated diaphragms of 0·0015-inch brass; they are sensitive to pressure-differences of less than 1 inch of water. In a typical installation about thirty indicators are distributed through each of several cross sections of the dam, with separate tubes leading to terminal boards at the crest. Pressure-measurements are made at least once every 2 weeks.

The Strength of Plain Concrete Columns. W. R. CRAWFORD and J. F. FRY (**Concrete Constr. Engng.*, 34, *443–449 ; Aug. 1939*).—The Author describes tests made at the Building Research Station to determine the pressures to be allowed in the design of plain concrete structures, and the relation between the " works cube-strength " (strength of 6-inch cubes) and the ultimate strength of columns made of identical concrete. Three types of concrete were considered, namely, (*a*) fine concrete, 1 : 1 : 2, water/cement ratio 1·45 ; (*b*) fine concrete, 1 : 2 : 4, water/cement ratio 0·60 ; (*c*) mass concrete 1 : 12, water/cement ratio 1·10. The proportions were by weight and normal Portland cement, river sand, and gravel were used. Two series of tests were made, with the loads applied axially and eccentrically respectively. The results are tabulated and plotted in curves.

Welded Shear Reinforcement for Concrete Beams. D. M. MCCAIN (**Civ. Engng., N.Y.*, 9, *418–421 ; July 1939*).—The Author states that the discontinuities in the reinforcing system of a concrete beam can be avoided by adopting diagonal bars welded to the top and bottom steel. Strain-gauge readings indicate that the stress in welded shear steel can be predicted with reasonable accuracy. He discusses theoretical and practical problems involved in the use of welded bars, and indicates their advantages over

ose stirrups. Records of costs are given, which lead the Author to timate that welded shear reinforcement will be about 10 per cent. cheaper an vertical stirrups—without including any saving in horizontal steel.

Tests of Reinforced-Concrete Slabs subjected to Concentrated Loads. E. RICHART and R. W. KLUGE (**Bull. Engng. Expt. Stn. Univ. Illinois,* *o. 314, 69 pp.; 20 June 1939*).—The tests described were made in two oups: the first group was confined to two rectangular slabs, 20 feet wide, feet long, and 6½ inches thick, simply supported on the two long edges and bjected to a single concentrated load, applied successively at a number points on the slab; the second group comprised eighteen slabs, of width feet 4 inches) equal to the span, simply supported on two edges and bjected to a single central load applied through distributing plates of rious shapes and areas. The results are presented in Tables and curves, d are summarized by the Authors in fifteen conclusions.

Moments in Simple Span Bridge Slabs with Stiffened Edges. V. P. ENSEN (**Bull. Engng. Expt. Stn. Univ. Illinois, No. 315, 105 pp.; 1 Aug. 939*).—The Author discusses the problem of the bridge floor-slab, spanning the direction of traffic, simply supported on two opposite edges, and iffened by curbs or beams on the other edges. He gives curves and Tables moments which permit a critical examination to be made of existing actice in the design of slabs. Illustrative problems are solved. The sults of the analysis indicate the possibility of using a slightly smaller ab-thickness, a higher percentage of moment being carried transversely the curbs and a relatively large moment being resisted by the curbs.

Deep Caissons for the Foundations of the Bronx-Whitestone Bridge, ew York. G. L. FREEMAN (**Engng. News-Rec.*, 123, *149–152; 3 Aug. 939*).—This bridge, over the East river, is a wire-cable suspension bridge aving a main span of 2,300 ft., two side spans of 735 ft. each and approach iaduct spans of a total of 245 ft. The foundations for the bridge included quare, rectangular, and circular concrete caissons and square hollow-wall elded steel box-caissons, the latter designed to float until the cutting-edge as at a depth of 100 ft. One of the circular caissons was founded 170 ft. elow ground-surface. Vertical jetting-wells and horizontal jetting-ozzles were employed in sinking through difficult material. The vertical ells were also used to admit drills and blasting materials for cleaning-off isintegrated bedrock.

Welded Cable Saddles for the Tacoma Narrows Suspension-Bridge, Vashington. J. JONES (**Canad. Engr.*, 77 (*11*), *3–5; 12 Sept. 1939*).—The Tacoma Narrows highway-bridge over Puget Sound has a span of ,800 feet, carrying a 24-foot reinforced-concrete roadway-slab, and is to e completed by June 1940. The design includes two parallel-wire cables, ach 17 inches diameter, of nineteen strands, forming a hexagon with its

apexes up and down. The Author discusses the design of the saddle which are cruciform in plan, 10 feet wide over the central third of the length and 4 feet 2 inches wide fore and aft. The saddle-length of 1 feet 9½ inches conforms with the tower design and gives a satisfactory bearing pressure for the cable wire in the saddle-trough. The reasons for the adoption of welding instead of casting the saddles are given, and th operations are described in detail.

A Notable Gauge Conversion in Germany. (*Rly. Gazette, Lond.*, 71 *434–435 ; 29 Sept. 1939*).—The Müglitz Valley line from Heidenau t Altenberg, in Saxony, has recently been converted from a gauge of 0·7 metre (2 feet 5½ inches) to standard gauge. The work entailed complete realignment at many points to eliminate level crossings and to reduce curvature, and included the construction of seventy-five new bridges and five short tunnels. The maximum gradient is 1 in 30 and the sharpest curve is of 140 metres (459 feet) radius. Special three-cylinder tank locomotives of the 2–10–2 type, with Schwartzkopf-Eckardt bissel trucks are employed. (ENGNG. ABSTRACTS (Mech.) 2, No. 323 ; Aug. 1939.)

Theoretical and Experimental Study of the Flow under Sluices L. ESCANDE (**Rev. Gen. Hydraulique*, 5, *21–34 ; 65–77 ; 131–139 ; Jan. Feb., Mar.–Apl., and May–June, 1939*).—In continuation of earlier wor (ENGNG. ABSTRACTS (Con.) 1, No. 342 ; *Nov. 1938*), the Author consider the general problem in which the downstream bottom is lower than th upstream, either by a vertical step or a gradient. He discusses two cases namely (1) where the width of the sluice is the equal to that of the cana and (2) where it is only a fraction. The theoretical implications of these conditions are worked out for both the drowned and the free conditions o flow. The formulas derived are in general in accord with the experiments as showing how the discharge is affected by the pressure in the contracte section, the relation between the upstream and downstream levels an the critical value between free and drowned conditions of flow.

Electric Heating of Sluice-Gates. H. FICK (**Wärme*, 62, *583–585 2 Sept. 1939*).—The Author describes tests made on the weir at Faulbac on the Main, about 12 km. upstream from Mayence, which is equipped wit electrical heating arrangements to prevent ice-formation and ensure fre working of the gates under winter conditions. The results have show that it is possible to effect such heating for a low current-consumption.

Aggressivity of Drinking Waters. H. GOLDSTEIN (**Rev. Univ. Min.*, 1 *398–409 ; Aug. 1939*). The Author discusses the corrosion of water-pipe and describes a method of its direct measurement. Tests were made wit stagnant and with circulating water, changed daily or at intervals o 48 hours. The corrosion-meter consisted of a conical flask holding 1 litr

water, closed by a stopper having two holes for glass tubes; the test-ece, a closely-spiralled mild-steel wire, 1 millimetre diameter, and 500 illimetres in length, was inserted in the flask. The Author states that e most favourable conditions for the formation of a protective coating metal are those corresponding with a low percentage of free carbonic id gas and a high content of oxygen; a lime-rust conglomerate then rms and arrests the continuation of corrosion.

Bacteria from Chlorinated Waters. M. LEVINE, P. CARPENTER, and M. COBLENTZ (**J. Amer. Wat. Wks. Assoc.*, 31, *1511–1523; Sept. 1939*).—he Authors describe studies of 162 cultures of bacteria isolated from 7 samples of water which had been chlorinated either with chlorine or ith ammonium sulphate and chlorine; 282 strains obtained by -purification of the cultures submitted were examined in detail. The esults indicate, on the whole, that survival of coli-aerogenes strains in hlorinated water is probably due to the presence of clumps of bacteria, r protection of the organisms by some constituent of the water, rather han to resistance of the individual bacteria to the action of chlorine. A hlorine residual of 0·2–0·4 parts per million, as now determined by rtho-tolidine, is not, in itself, a dependable criterion of adequate steriliza-on of water.

MECHANICAL ENGINEERING.

Emergency Power Plant for the New Westminster Hospital. (**Oil Engine*, 7, *110–111; Aug. 1939.*)—Two diesel-engined generating sets have een installed in a basement power-house. Each has a capacity of 37½-ilovolt-amperes, three-phase 50-cycle alternating current being generated t 400 volts, and is equipped with a circulating water-cooling radiator. ach engine with its direct-coupled alternator, a 105-volt 1-kilowatt xciter overhung from the alternator, and a voltage-regulator driven by elt from the exciter, is mounted on a single bedplate, supported on rubber nsulation. A 100-volt battery installation is also kept on constant trickle-harge from the mains or the diesel sets.

The Mechanical Equipment of Air-Raid Shelters. H. C. BECHTLER (*Schweiz. Bauztg.*, 114, *113–117; 2 Sept. 1939*).—The Author discusses the roblems involved in the maintenance of essential services in underground helters, including the provision of ventilation, independent sources of light nd power, and auxiliary plant such as water-pumps, sewage-pumps, ignalling apparatus, telephones, etc. He deals in detail with gas-filters, entilating plants, carbon-dioxide absorption (where closed-circuit ven-ilation is adopted), heating, and air-conditioning. The article is followed (*pp. 117–119*) by a description of a diesel-engine emergency plant.

Experimental Study of a Pelton Jet and of the Conditions of Flo along the Internal Surfaces of Turbine-Blades. A. Tenot (**Rev. Gé Hydraulique*, 5, *119–130 ; May–June, 1939*).—The Author had observ that, with Pelton-wheel turbines working under high heads, there we areas of material wear on the point of the valve and the inner surface the buckets, which could not be accounted for by the presence of suspend matter in the water-supply. He conducted a series of experiments investigate these phenomena, using a 34-millimetre-diameter pelton jet, microscopically-small pitot tube, and a deflector which could be dispos in various positions within the jet. It was discovered that these areas deterioration formed at points where the flow was turbulent, causi uneven pressures and, in places, vacuum pockets. He presents a résur of the experimental work and the conclusions drawn therefrom, togeth with a mathematical analysis of a hypothetical case.

The Ponte Gardena Hydro-Electric Power-Station. G. Castella (**Elettrotecnica*, 26, *578–597 ; 10 Sept. 1939*).—A detailed description given of the design and construction of this station on the Isarco rive which was brought into service in December 1938. With a maximu flow of 80 cubic metres (2,825 cubic feet) per second, the annual productio of power will be 230 million kilowatt-hours. The plant comprises thr vertical-axis Francis turbines of 16 kilowatts each, installed in an unde ground chamber 50 metres (164 feet) long, and 15 metres (49 feet) wid and the output, at 10,000 volts, is transformed to 65,000 and 130,0 volts in transformers with two secondary windings, which are connect in parallel or in series according to the transmission voltage required.

A New High-Capacity Air Circuit-Breaker. L. R. Ludwig ar G. G. Grissinger (**Elect. Engng., N.Y.*, 58 (*Trans.*), *414–418 ; Aug. 193* —The Authors describe a de-ionization arc interrupter which is stated be equally effective for both direct-current and alternating-curre circuits. In an air circuit-breaker designed to utilize this interrupt carbon arcing surfaces are replaced by refractory metal, and laminate brush-type main contacts are replaced by silver-faced solid copper. Te results indicate that the use of the interrupter reduced considerably t noise and disturbance usual when heavy short-circuits are opened air breakers. The ionized flame which usually accompanies interruptio was also reduced, whilst no danger of flashover between phases or to ear was apparent.

Locomotive Hornblocks (with a Note on Frame Stresses). C. Clarke (**J. Instn. Loco. Engrs.*, 29, *615–639 ; July–Aug. 1939*). T Author considers the forces acting on driving-axle horncheeks, both steam locomotives and for electric locomotives with geared and r drives. He discusses design considerations, and the factors produci

ear, and considers the stresses set up in the main frames owing to thrust nd tractive effort.

An Investigation of Wrought-Steel Railway-Car Wheels. T. J. Dolan and R. L. Brown (**Bull. Engng. Expt. Stn. Univ. Illinois, No. 312, 1 pp.; 15 Aug. 1939*).—The object of the tests described was to ascertain he most highly stressed portions of the wheel under several types of oading and to calculate (from strain measurements) the value of the larger tresses in the wheel under various loading conditions. The wheels were f the standard A.A.R. design, and tests were made on wheels of carbon-teel and also of silico-manganese alloy-steel. They included mounting ests, and vertical-load, combined vertical- and lateral-load, and ultimate-oad tests, with a photo-elastic analysis. The results are presented in Tables and curves and are discussed in detail.

Track-Recording Car on the Great Indian Peninsula Railway. M. F. O. de Mellor (**Engng.*, 148, *253–255; 1 Sept. 1939*).—The car is lesigned to record the discomforts experienced by the traveller, and to eparate their technical causes, record them, and make a mark on the rack at the appropriate spot. Means are provided for detecting and ecording low rail-joints, lateral swinging, curvature, cross-level (both on

v. Engrs., 51,
l differences
between bare and shielded arcs, the chemical and metallurgical differences between bare-wire and shielded-arc weld-metal, and the characteristics of electrode-coverings. He describes the various tests to determine the suitability of electrodes and tabulates the types of corrosion-resisting steel welding electrodes which are available commercially. He considers that the principal improvements effected by the use of coverings are:—(1) improved ductility and tensile strength of deposited metal; (2) greater arc stability; (3) higher speed of welding; (4) better penetration into corners; (5) improved surface appearance.

Radiographic Control of Welded Joints. F. Campus and H. Louis (**Rev. Univ. Min.*, 15, *345–360; July, 1939*).—A résumé is presented of the problem of the control and testing of welded joints and the conclusion is drawn that radiography by itself is not always sufficient. The Authors discuss X-ray testing and control, indicate the principal defects encountered, and give a detailed description of a travelling testing-plant.

Welding Copper Steels. W. Spraragen and G. E. Claussen. (**J. Amer. Weld. Soc.*, 18 (*Weld. Res. Suppl.*), *289–301; Sept. 1939*).—The Authors review the literature published up to the 1st July, 1937, on the

welding of copper steels. A bibliography of eighty-four references included.

Service Tests with Lubricants for High-Speed Oil Engines. A. WILFORD (**J. Inst. Petroleum*, 25, *607–628 ; Sept. 1939*).—Lubricating-tests have been carried out during the past 7 years by the London Passeng Transport Board. The Author discusses investigations to determine th optimum periodicity of oil-changes, the efficiency of flushing oil, and th useful life of engine-oil by-pass filters. He summarizes the results of tes with solvent-refined oils, and cites the specification of an oil which, comparison with the standard lubricant of 1932, increased engine milea by 11 per cent., reduced oil-consumption by nearly 7 per cent., reduce cylinder-wear by 13·5 per cent., and reduced engine-failures due to seizur and bearing-failures by 60 per cent.

Telemetering of Steam and Electricity at Indianapolis. T. W. AYTC (**Elect. World, N.Y.*, 112, *584–586 ; 642 ; 26 Aug. 1939*).—The recentl rebuilt C. C. Perry plant of the Indianapolis Power & Light Co. is divid into two sections, approximately ½ mile apart. The steam headers of the two sections are connected by a 20-inch underground steam main. A clo interrelationship of electric and steam generation and distribution problem exists, rendering it desirable to have at the load-dispatcher's office remo indications of both steam and electric quantities for efficient and successf operation of this dual distribution system. A detailed description given of the telemetering installation adopted, which consists essential of two units, namely, a transmitter located at the points where th measurements are made and a receiver at a distant point.

MINING ENGINEERING.

Methods of Support at Machine-Cut Longwall Faces. (**Trans. Mi Inst. Scotland*, 59, *104–117 ; 26 July 1939*).—The Report of the Minir Institute of Scotland Safety Committee (Support of Roof and Side describes examinations of several systems of support in actual operatio and measurements of the areas of unsupported roof where persons a exposed in the normal course of working. The operations performed each class of workman are discussed and attention is drawn to the practic difficulties which tend to deter or delay the erection of supports, necessitate the removal of supports, whereby workmen are exposed excessive areas of unsupported ground. Faults and recognized disturbanc which call for special support in addition to the normal supports are d cussed, and comparisons are made of the number of shifts worked p accident from falls of ground where, apart from the systems of suppo the conditions were reasonably comparable.

Roof-Control. W. H. BELLIN (**Colliery Engng.*, 16, *284–285 ; Aug. 39*).—The Author cites practical instances from South Wales collieries support of the conclusion of Mr. H. T. FOSTER and Dr. M. A. HOGAN NGNG. ABSTRACTS (*Min.*), 2, No. 26 ; *Feb. 1939*) that the load carried the roof supports at the working face of a coal-seam bears no definite lation to the depth of the seam from the surface and that only a certain ickness or zone of the beds overlying the seam subsides when the coal is ing worked.

Interpretation of Leached Outcrops. R. BLANCHARD (**J. Chem. etall. Min. Soc. S. Afr.*, 39, *344–374 ; May, 1939*).—The estimation of the ture of the underlying ore from the character of leached outcrops or gossans" is based upon the fact that limonite products derived from y given oxidized mineral usually retain certain physical characteristics that mineral which enable it to be identified. The Author reviews the rly history of this form of investigation and describes the procedure llowed in assessing the evidence provided by leached outcrops. He scusses the application of the method in searching for ore bodies and gives ustrative examples. He states that it has been possible to predict not ly the type of ore, but also the quantity from the physical character and llular structure of the leached outcrop.

The Preparation of Upper-Silesian Complex Lead-Zinc-Sulphur Ores. . GLATZEL (**Metall u. Erz.*, 36, *379–383 ; 409–415 ; July and Aug. 1939*). -The Author discusses the mode of occurrence and the mineralogical aracter of the ore bodies worked by the Neue Viktoria Neuhof mine, and scribes the treatment process adopted at the new concentration-plant. e reproduces flow-sheets which are supplemented by particulars of the paratus and of the reagents used for the preliminary wet separation, the ad-zinc flotation, and the iron pyrites flotation. He explains the system controlling the various processes and presents output and cost data, ustrating the results achieved by the new process in 1938.

Oil-Engined Locomotives for Gassy Mines. (**Engineer, Lond.*, 168, *62–264 ; 8 Sept. 1939.*)—The design of mine locomotives is discussed, and e type and severity of the tests to be applied are explained. A descrip- on is given of a locomotive for colliery work, the design of which is based pon main-line locomotive practice. Special arrangements had to be ade to render the cylinder-heads flameproof in accordance with Mines epartment requirements, and the inlet and exhaust equipment had to e specially designed. The complete equipment is carried within a height f 5 feet and a width of 3 feet 4 inches, corresponding to a 2-foot rail- auge. The engine develops 25 horsepower at 1,300 revolutions per inute. The locomotive can haul a train carrying 100 men up gradients f 1 in 20. Road speeds of up to 15 miles per hour can be attained.

A New Face Belt Conveyor. (**Iron Coal Tr. Rev.*, 139, *383 ; 1[illegible] Sept. 1939.*)—The conveyor, designed for long faces, is of the troughed-bel[illegible] type. The pans forming the protection of the bottom belt are beade[illegible] along the sides, to afford the maximum rigidity. At one end of each pa[illegible] side-plates are riveted, which support the ends of the V-roller spindle[illegible] and have tapered slots which drop on to a bar welded to the end of the nex[illegible] pan, thus forming a rigid lateral lock to the run, and rendering setting ou[illegible] of alignment impossible. The top rollers are $2\frac{1}{2}$ inches or 3 inche[illegible] diameter. Each pair of rollers is tilted $12\frac{1}{2}$ degrees to the horizontal, an[illegible] they are mounted so that they almost touch at the base of the Vee ; the[illegible] are inclined 5 degrees in the direction of belt-travel, so that the belt i[illegible] automatically centralized. The face side of the belt is $12\frac{1}{2}$ inches high.

Cables for Shot-Firing. H. Stafford (**Trans. Instn. Min. Engrs.*, [illegible] *465–474 ; Sept. 1939*).—The Author describes investigations made by th[illegible] Exploder Sub-Committee of the Explosives in Mines Research Committee[illegible] He discusses the requirements for a good shot-firing cable, and tabulate[illegible] data in regard to the length of life, cost, and frequency of misfires fo[illegible] cables in general use. Experimental cables were tested ; the results ar[illegible] presented in a Table. Cables for simultaneous shot-firing were als[illegible] investigated. Cotton-braided twin cables were liable to cause misfire[illegible] especially when wet. Twin cab-tire cables were better, but misfire[illegible] occurred which could be accounted for only by assuming a short-circui[illegible] between the conductors of the cable. The problem was solved by th[illegible] provision of single-core cables, wherever possible laid one up each side o[illegible] the roadway. There were no misfires due to cable faults when single-cor[illegible] cables were used.

The Estimation of Ventilation Air-Temperatures in Deep Mines[illegible] C. W. B. Jeppe (**J. Chem. Met. Min. Soc. S. Afr.*, 40, *1–13 ; July, 1939*).— The Author presents a detailed analysis of the factors involved in th[illegible] estimation, and discusses the modification and adjustments necessary i[illegible] order to obtain correct results. He studies the behaviour of air unde[illegible] variations of temperature and pressure, the sources of heat in mine ai[illegible] the rate of cooling of rock, and the transfer of heat between air and rock i[illegible] mine workings. His results are summarized in numerous Tables an[illegible] curves.

The Estimation of Methane. S. W. Sleigh (**Colliery Guard.*, 15[illegible] *381–383 ; 8 Sept. 1939*).—The Author describes a precise laborator[illegible] apparatus, designed for an accuracy of 0·01 per cent. over a range of fro[illegible] 0 to 6 per cent. of methane, and utilizing the process of combustion on a[illegible] electrically-heated platinum wire. Test results are tabulated.

Ignition of Firedamp by Explosives. B. Lewis and G. von Elbe (*ept. Investign. U.S. Bur. Min., No. 3463, 11 pp.; Sept. 1939*).—The ıthors discuss the influence of temperature, chain carriers, and diluent s in the ignition of methane and air, and the processes occurring in the ne of contact between firedamp atmosphere and detonation products om explosives. They suggest that an ignition hazard is produced by 'olds" or "pockets" in the zone of contact in which firedamp is surınded on several sides by detonation products. In freely-suspended arges the ignition hazard presented by the rim at the end of the cartridge thest from the detonator is interpreted on the basis of the mode of ape of gas from the cartridge. The nature of the primary flame is scussed, and the conclusion is drawn that this is luminous gas formed by e detonation of the outer surface of the cartridge. The theory is content with the conclusions of Beyling and Schultze-Rhonhof and of ıdibert that particles and gaseous products participate in the ignition ocess.

Notes on Methods of Detection and Dealing with "Heatings" and res in Coal-Mines. E. B. Park (*Trans. Min. Geol. Met. Inst. India*, 35, *7–198; June, 1939*).—The Author classifies the stages of progress of a eating" as perceived by the senses as follows:—(1) "sweating" on of and sides; (2) "gob stink" evident; (3) paraffin or petrol smell; "burnt tar" smell; (5) smoke appears. The treatment of the fire pends on whether it is (*a*) of small dimensions and easily accessible; of large dimensions or inaccessible. In the former case, the fire should dug out after covering with wet sand; the use of water is not advocated. the latter case the area must be sealed off. Practical details in the ecution of these operations are discussed.

Illumination and Dust Problems under Modern Conditions of Mining. I. Graham (**Min. Elect. Engr.*, 20, *103–109; Sept. 1939*).—The ıthor discusses the effect of dust upon illumination, and emphasizes the cessity for frequent cleaning of lamp well-glasses. He reviews methods reducing or suppressing dust formation during shot-firing and drilling, loading-points, at the coal-face, and in return airways.

Methods of Rock-Dusting American Coal Mines. J. J. Forbes (*ept. Infmn. U.S. Bur. Min., No. 3465, 22 pp.; Sept. 1939*).—A study rock-dusting practices leads to the following conclusions:—(1) although e number of mines using rock-dust is increasing, and more rock-dust is ing used, rock-dusting practices in the United States fall far short of ving absolute protection against coal-dust explosions; (2) State laws gulating the safety of mines are, in general, entirely inadequate with spect to rock-dusting; (3) the Bureau of Mines recommends that all al-mines except anthracite be rock-dusted in every part, and that rock-

dust barriers be used as a secondary precaution, but not in lieu of gener rock-dusting; (4) machinery for distributing rock-dust, as well analytical equipment for inspection purposes, has attained a fairly advanc stage of development; (5) limestone or gypsum is readily accessible to coal-fields of the United States, and this material can be delivered to t mines for rock-dusting purposes at a reasonable cost; (6) the average co of rock-dusting in twenty-seven mines where the practice is consider good amounts to $0·0089 per ton of coal mined, or $0·0229 per linear fo of entry; (7) during the past 9 years rock-dust is credited with havi stopped or limited explosions in twenty-six of sixty partly-rock-dust mines, and thereby has unquestionably saved the lives of several hundr persons.

Testing and Design of Respiratory Protective Devices. H. H. Schre (*Infmn. Circ. U.S. Bur. Min., No. 7086, 11 pp.; Sept. 1939*).—Th Author describes the design and operating principles of the various typ of respiratory equipment approved by the U.S. Bureau of Mines. H reviews the Bureau's requirements for supplied-air respirators (hose mask and for gas masks. Those for masks for protection against carbo monoxide are described in some detail. Test apparatus, test procedur and approval requirements of dust respirators are also described.

Note.—The Institution of Civil Engineers as a body is not responsib either for the statements made, or for the opinions expressed, in t Papers or Abstracts published.

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NOTE.—*Pages* [1] *to* [16] *can be omitted when the Journal is bound in lume form.*

NOTICES

No. 1, 1939–40

NOVEMBER, 1939.

THE INSTITUTION OF CIVIL ENGINEERS

SPECIAL ANNOUNCEMENTS.

CENTRAL REGISTER, MINISTRY OF LABOUR.

A further letter on the subject of the Central Register, dated the 14th ctober, together with a questionnaire card, was issued with the October urnal to Corporate Members in Great Britain. Any "home" Member ho has not received the letter and card should apply to the Secretary r copies.

NATIONAL SERVICE (ARMED FORCES) ACT, 1939.

A notice relating to this Act, as affecting Students of The Institution Great Britain, accompanied the October Journal. Any "home" udent who did not receive this notice can obtain a duplicate upon quest to the Secretary.

ARMY OFFICERS' EMERGENCY RESERVE.

Corporate Members who wish to apply for Commissions through the rmy Officers' Emergency Reserve (the age limits for which are 31–60 ears) may obtain the requisite form from the Secretary of The nstitution, who will also furnish, upon request, a certificate of memberip for attachment to an application.

A

ORDINARY MEETINGS, SESSION 1939–40.

Tuesday, 21 *November, at* 3 *p.m.*—For the main purpose of taking ballot for the election of new members and of reading the names of cand dates for election passed by the Council for ballot.

Tuesday, 19 *December, at* 3 *p.m.*—Ballot for the election of ne members.

Further meetings, as arranged, will be announced in the Journal.

GENERAL ANNOUNCEMENTS.

SIR CLEMENT HINDLEY, PRESIDENT INST. C.E.

Sir Clement Hindley is President of The Institution for Session 1939–4 The usual formal induction of the President did not take place at th Ordinary Meeting on the 7th November nor was his Presidential Addre read, but Sir Clement has furnished an Address prepared in the light present conditions, which is printed on pp. 1–6 of this Number of th Journal.

THE COUNCIL.

The names of the Members of the Council, Executive Committee, an other Committees of the Council for Session 1939–40, will appear in th December Number of the Journal.

CORPS OF ROYAL ENGINEERS.

A form of certificate was issued recently to Associate Members und 31 years of age and to Students of The Institution who desired to apply f a Commission in the Royal Engineers. It will assist the office records those who have received Commissions, or who have been drafted to Officer Training Units as a result of such applications, will kindly notify th Secretary.

CANCELLATION OF VISIT TO THE UNITED STATES AND CANADA.

The following correspondence passed between the Presidents of the stitution of Civil Engineers and the American Society of Civil gineers :—

The Institution of Civil Engineers,
Great George Street,
Westminster, S.W.1.
29 August, 1939.

D. H. Sawyer, Esq.,
President,
American Society of Civil Engineers,
Thirty-Three West Thirty-ninth Street,
New York, U.S.A.

ar Mr. Sawyer,

It was with very deep regret and reluctance that it was found necessary last day to cancel the visit to America of the party of engineers from this Institution. view of the grave international situation and the fact that a number of members l found themselves unable to join the party at the last moment owing to other nmitments, together with the responsibility of taking members and their ladies on h a long journey with the danger of war imminent, I felt that there was no other rse open to me.

We were all looking forward very much to meeting members of the American iety of Civil Engineers, and to creating very close co-operation between the two ieties for the future.

I trust there may be some other opportunity to do this, and in the meantime I e to inform you that it had been proposed to present to the American Society of il Engineers on behalf of their British brethren a replica of the Myddelton loving as a token of our feelings of friendship and esteem. Full particulars of this cup given in the enclosed pamphlet and it is proposed to send it to you at the first portunity by a member of one of our two Societies who may be going over, and can sonally hand it to you.

Yours sincerely,
(Signed) W. J. E. Binnie,
President.

American Society of Civil Engineers,
Thirty-Three West Thirty-ninth Street,
New York.
September 11, 1939.

William J. E. Binnie, Esq., President,
Institution of Civil Engineers,
Great George Street,
Westminster, S.W.1,
London, England.

Dear Mr. Binnie,

This letter is written in acknowledgment of your communication of August 29, 9, confirming your cable of August 25, 1939, advising that the party of Engineers resenting the Institution of Civil Engineers, contemplating attending the International Engineering Meeting to be held in New York City the week of September 4th s necessarily abandoned due to the threat of war.

We fully understand that no alternative was left to you to act other than as y did, and it was a demonstration of best intentions that you awaited almost the saili of the steamer before you made your decision.

The affair which had been arranged with the Institution of Civil Engineers and Engineering Institute of Canada was planned in great detail and with great enthusias and I am sure it would have been a rare opportunity to foster a fraternal spirit amo English speaking engineers. We deeply regret that the opportunity to become bet acquainted with your representatives and yourself must await a more fortuit occasion.

The situation which apparently faces your country is a tragic one as related to profession of engineering. For a long period of time the engineers have been creat useful things for mankind, enterprises that have given added comfort, convenie and luxury to modern-day living. To contemplate the destruction of many of the the necessary pause in the advance of science, and the further fact that the techni mind must now turn its brilliant ability from creation to waste leaves us all rat helpless and discouraged.

But, in spite of this interruption, and the loss of useful things which the engin has developed, his creative genius still remains, his enthusiasm and devotion to pub service will survive, and he will again play his part in world progress.

It is noted that your feelings of friendship and esteem to the American Soci of Civil Engineers will be evidenced by the presentation to our organization of a repl of the Hugh Myddelton loving cup which will be presented by one of your represen tives who may be visiting the United States in the near future. Such a gift will highly appreciated, will be displayed where our members can view it, and will alwa remain a symbol of mutual friendship and esteem between the Institution and Society.

With kind regards to yourself and to the members of the Institution of Civil En neers from the membership of our Society, I remain,

Very cordially yours,
(Signed) D. H. Sawyer,
President.

[Lord Lothian, British Ambassador to the United States, will present the repl of the Myddelton Cup to the American Society of Civil Engineers on behalf of Institution.—Sec. Inst. C.E.]

SIR CHARLES PARSONS MEMORIAL LECTURE, 1939.

Mr. H. L. Guy, D.Sc., F.R.S., M. Inst. C.E., had agreed to deliver t Parsons Memorial Lecture on the subject of “ Some Researches on Stea Turbine Nozzle-Efficiency ”, but, owing to suspension of the Instituti Meetings, the Lecture will not be formally read. The Royal Society, w were responsible for the foundation of the Lecture, has consented to M Guy’s Lecture being printed in the Journal of The Institution, and it w appear in the December Number.

VERNON-HARCOURT LECTURE, 1939–40.

Mr. A. C. Gardner, M. Inst. C.E., had agreed to deliver the Vern Harcourt Lecture on the subject of “ The Construction of Deep-Wa

ays", but in the present circumstances the Lecture will not be formally d. It will, however, be printed in a subsequent Number of the Journal.

JAMES FORREST LECTURE, 1940.

Dr. E. V. Appleton, M.A., F.R.S., was appointed the James Forrest cturer for 1940. It is hoped to print his Lecture later on in the Journal.

EXAMINATIONS.

It is hoped to hold the April, 1940, Examinations as usual in London d Overseas. They may also be held in the Provinces, provided that there a sufficient number of candidates.

CHARLES HAWKSLEY PRIZE.

The following subjects have been set for the competition to be adjudged March, 1940 :—

A combined underground garage and air-raid shelter.

A water-tower.

The Prize, of the value of £150, is awarded for the best design of an gineering structure combining artistic merit with excellence of construc-onal design. Students and Associate Members under 30 years of age are igible to compete, and full particulars regarding the competition, with tails of the subjects set, may be obtained from the Secretary.

C. C. LINDSAY CIVIL ENGINEERING SCHOLARSHIPS.

Regulations for the award of these Scholarships, sanctioned by the oard of Education, may be obtained on application to the Honorary ecretary of the Glasgow and District Association, Mr. William MacGregor, .Sc., Assoc. M. Inst. C.E., Engineering Department, The University, lasgow, W.2. Eligibility for the award of these scholarships, which are ch of the value of not less than £25 per annum, is confined to Students

of The Institution who are members of the Glasgow and District Association of The Institution and are British subjects of Scottish parentage

LENGTH OF PAPERS PRESENTED TO THE INSTITUTION.

The following extract from the "Memoranda for the Guidance of Authors" is published for information :—

"It is of great importance that Authors . . . should confine themselves as far as practicable to those features of their subject which are novel and likely to be of interest and value to their fellow engineers.

"It has been found that Papers of 5,000 words and less have dealt adequately with one aspect of a subject and, when discussed, have given rise to an effective discussion. A Paper of 15,000 words is long enough for the presentation of any subject to The Institution, and if this limit is exceeded, it will be doubtful if the Paper can be accepted for publication except in an abridged form, as the space available in the Journal is limited."

The Council invite Original Communications on suitable subjects of engineering interest. For approved Papers the Council may award premiums, arising out of endowments instituted for the purpose, details of which are given below. No distinction will be made, in the adjudication, between Papers received from members of The Institution and others in connexion with the award of premiums, except where eligibility is limited by the directions of the donors.

Copies of a pamphlet containing memoranda for the guidance of authors in the preparation of Original Communications, can be obtained on application to the Secretary.

MEDALS, PREMIUMS, AND AWARDS.

The following are the Medals, Premiums, and Prizes available for award :—

1. The TELFORD FUND produces an income of £220 annually, to be expended in the provision of gold medals and premiums under the direction of the Council.

2. The BAKER GOLD MEDAL is awarded triennially by the Council of The Instituton to a person selected by them as a mark of distinction in recognition of his services for the promotion of or otherwise in connexion with development in engineering practice or investigations into problems with which Sir Benjamin Baker was specially identified. In making the award preference is to be given to the person primarily responsible for the

velopment or investigations, as described in a Paper accepted by The stitution, especially if such person is the author of the Paper. The next vard will be made in 1940.

3. The James Alfred Ewing Gold Medal was found in 1936 in emory of Sir Alfred Ewing, Honorary Member. The income, derived om an endowment fund contributed jointly by Lady Ewing, by The stitution, and by friends and admirers of Sir Alfred Ewing, is to be pended in the provision of a Gold Medal together with a bronze replica r award to a person, whether a member of The Institution or not, for ecially meritorious contributions to the science of engineering in the field research.

4. The Manby Fund produces an income of about £10 a year to provide premium or premiums for Papers read at the meetings.

5. The Howard Bequest is expended in providing a prize or medal the author of a treatise on any of the uses or properties of iron or to the ventor of some new and valuable process relating thereto, such author or ventor being a member or Student of The Institution. The annual come amounts to nearly £9. This prize, which consists of a gold medal nd of a premium, is awarded every 5 years. The next award will be made 1942.

6. The Crampton Bequest produces an income of about £14 annually, ut of which is provided the "Crampton Prize", consisting of a medal or ooks or otherwise for presentation to the author of the best Paper on The Construction, Ventilation and Working of Tunnels of Considerable ength", or failing that, on any other subject that may be selected.

7. The Trevithick Memorial Fund is expended in the provision of a remium awarded periodically for Papers presented to The Institution.

8. The Indian Premium, of about £33, is awarded annually to the uthor, being a Corporate Member of The Institution in practice in India, f the best Paper received during the year on a subject connected with ndian engineering. This special award, when made, will be irrespective f any other recognition of the merits of such Paper which the Council ay accord to it in the ordinary course.

9. The Webb Prize is awarded in money, instruments, or books, by he Council every 3 years, or oftener, in their discretion, to the author of he best Paper on "Railway Machinery", or upon some branch of Railway achinery, to be prescribed from time to time by the Council.

10. A Coopers Hill War Memorial Prize. The available income

(about £21) is to provide a bronze medal, a certificate, and a money pri The selection is made from among the Papers by Corporate Membe which are published by The Institution in each sessional year, and t prize is to be given for the Paper which, in the opinion of the Council, most suitable for the award to be made in that year. The award is ma irrespective of the age of the author and also irrespective of any oth award made for the same Paper. In a case of joint authorship by Corpora Members, additional medals, certificates, and division of the cash payme are made.

11. The George Stephenson Gold Medal is awarded from time time by the Council for Papers of merit.

12. The James Watt Gold Medal is awarded from time to time the Council for Papers on mechanical engineering subjects.

Awards Open to Students of The Institution.

13. The Miller Fund provides premiums or prizes for the Studen of The Institution, upon the principle of the "Telford Fund." Th Fund realizes £180 per annum. Out of this Fund the Council may awa a Scholarship—called "The Miller Scholarship of The Institution of Civ Engineers"—not exceeding £40 in value, tenable for a period of not mo than 3 years, where the value and importance of a Paper justify suc recognition.

14. The James Forrest Medal is in the ordinary course awarde annually to the Student of The Institution who contributes the bes Paper received from that class.

15. The James Prescott Joule Medal is awarded in every thir year to a Student of The Institution for the best Paper presented on a engineering subject, "preference being given to a Paper dealing with th transformation of energy." The medal will next be in the award of th Council in 1942.

No Paper will be accepted from a Student in competition for a Premiu after he has reached the age of 25 years, when he is qualified by age f election into The Institution.

A Students' Paper which is to be read before a Local Association o The Institution, and which the author desires to submit in competition f a Premium, must be sent to the Institution by the Honorary Secretary o the Local Association concerned, for registration, *before* being read.

The Council will not make any award unless a Communication of
equate merit is received, but may give more than one Premium if there
e several deserving memoirs on the same subject.

THE LATE DR. J. H. T. TUDSBERY.

Dr. Tudsbery, who was Honorary Secretary of The Institution at the me of his death, and who had been Secretary from 1896 to 1922, passed vay on the 10th October, 1939. A memoir appears at p. 71 of this umber.

LONDON BUILDING ACTS (AMENDMENT) ACT, 1939.

Sir Cyril Kirkpatrick has been nominated to represent The Institution the Tribunal of Appeal to be formed under the London Building Acts mendment) Act, 1939, and Dr. David Anderson to act as his deputy. ne Act comes into force on the 1st January, 1940.

ALFRED YARROW HOME AND HOSPITAL FOR CHILDREN.

The Council have appointed Mr. C. G. Du Cane and Mr. F. E. Went-orth-Sheilds, MM. Inst. C.E., to fill vacancies arising in the Committee Management, owing to the death of Sir Henry Japp, M. Inst. C.E., and e retirement of Mrs. W. N. McClean.

CHANGES OF ADDRESS.

Owing to the number of changes of address incidental to service with .M. Forces, it is not practicable to register such addresses in the List of embers. It is therefore suggested that a home (private) address be aintained, from which communications issued by The Institution might e re-directed. If, however, this is impracticable, The Institution may, in ecial circumstances, arrange for the dispatch of the Journal as issued to service address.

For office purposes, a record will be kept of members' service with H.M. orces, and members are asked to inform the Secretary of such service, e. unit, rank, promotions, decorations, etc.

THE JOURNAL.

The publication dates of the Journal for Session 1939–40 are t… 15th November and December, 1939, and the 15th January, Februar… March, April, June, and October, 1940.

BINDING CASES FOR THE JOURNAL.

The eight Numbers of the Journal (November, 1939, to October, 194… for Session 1939–40 will be arranged so that they may be bound in volum… form.

Members who require binding cases only and intend to make their ow… arrangements for binding should send the sum of 3*s*. 6*d*. to cover the actu… cost of cases and postage with their annual subscriptions. The bindi… cases will be dispatched to them in October, 1940.

Members who prefer the Institution printers (Messrs. William Clow… & Sons, Ltd.) to undertake the binding, should, however, send to th… Secretary of The Institution, with their annual subscription, the sum … 10*s*. to cover the actual cost of binding cases, binding, and postage, an… when they have received the October, 1940, Journal, they should forwar… the eight Numbers of the Journal to Messrs. William Clowes & Sons, Ltd… Duchy street, Stamford street, S.E.1.

Non-members and societies who require binding cases for their copi… of the Journal, or who require their copies to be bound by the Institutio… printers, should send the appropriate amounts, detailed above, to Messr… William Clowes & Sons, Ltd.

TEMPORARY BINDING COVERS FOR THE JOURNAL.

Arrangements have been made to supply members with sets of thr… temporary binding covers to hold the eight annual Numbers of the Journa… They are in full cloth and lettered in gilt on the spine to aid in the read… reference to a particuar Number. These are intended for the use … members who do not intend to bind permanently their copies of the Journa… and also for those who would like a temporary binding cover for the vario… Numbers issued during the year until the full set is ready for binding. T… charge will be 8*s*. (post free) for the set of three covers. Remittanc… should be forwarded to the Secretary.

READING ROOMS AND LIBRARY.

Members are reminded that the Reading Rooms and Library are pen during normal office hours in daylight. An air-raid shelter accomodating some 50 persons is available for members who may be on siness in the building during an air raid and for the Institution Staff.

The normal loan service of books from the Library is also available r the use of members.

TRANSFERS.

Since the 4th July, 1939, the Council have transferred thirteen Associate embers to the class of Members.

DEATHS AND RESIGNATIONS.

The Council have received, with regret, intimation of the following eaths and resignations :—

DEATHS.

DAVIES, John Vipond. (E. 1910.)	*Member.*
FYSON, Alfred. (E. 1875. T. 1884.)	,,
MACKISON, James Walls, C.I.E., B.Sc. (E. 1900. T. 1913.)	,,
PARK, James Harvey Williamson, O.B.E., B.Sc. (E. 1893. T. 1912.)	,,
TUDSBERY, John Henry Tudsbery, D.Sc. (E. 1885. T. 1892.) (*Honorary Secretary.*)	,,
KINTON, Cyril Roy. (E. 1927.)	*Associate Member.*
SEHEULT, Leo Gabriel. (E. 1914.)	,, ,,

RESIGNATIONS.

BROWN, James. (E. 1900. T. 1905.)	*Member.*
GIBBS, George. (E. 1904.)	,,
TAYLOR, Arthur. (E. 1898.)	,,
FITZGIBBON, Henry Elliot, B.A., B.A.I. (E. 1920.)	*Associate Member.*
MEIN, Owen Coore. (E. 1913.)	,, ,,
NASH, Whitwell Tryon. (E. 1905.)	,, ,,
ROTTER, Edward Richard Ernest. (E. 1896.)	,, ,,
BALLARD, Geoffrey Charles. (A. 1932.)	*Student.*
GOSSOW, James Mortimer. (A. 1932.)	,,
IVENS, William Ralph Coleman. (A. 1939.)	,,
SEWELL, Robert Elliot. (A. 1937).	,,

RECENT ADDITIONS TO THE LIBRARY.

[Journals, Proceedings of Societies, British Standard Specifications, etc., are not t included.]

ACTIVATED SLUDGE. *See* SEWAGE-DISPOSAL AND SEWERAGE.

AERONAUTICS. ROYAL AERONAUTICAL SOCIETY. "Handbook of Aeronauti Vol. 3. Design, Data, and Formulæ—Aircraft and Airscrews." 3rd ed. 193 (Pitman.) 20*s.*

AIR DEFENCE. BRITISH CAST IRON RESEARCH ASSOCIATION. "A.R.P. for Cupo Furnaces." 1939. 2*s.*

—— HALL, J. & E., LTD. "Report on Occupancy Tests of Air Raid Shelters f Factory Workers." 1939. (Lewis.) 2*s.*

—— SAMUELY, J., and W. HAMANN. "Civil Protection." 1939. (Arch. Press 8*s.* 6*d.*

The provisions of the Air Raid Precautions Act, 1937, and of the Civil Defen Act, 1939, are detailed, and their technical applications are explained. Gover mental recommendations in regard to structural defence, shelters, lighting restri tions, and camouflage are reviewed, and the action and effects of bombs are dea with in detail. Tabulated data are given to aid the design of bomb-proof shelte

AIRSHIPS. ROSENDAHL, C.E. "What about the Airship?" 1938. (Scribne 10*s.* 6*d.*

ASBESTOSIS. *See* SILICOSIS.

BIOGRAPHY. EVE, A. S. *"Rutherford. Being the Life and Letters of the Rt. Ho Lord Rutherford, O.M." 1939. (Cambridge University Press.) 21*s.*

—— EWING, A. W. *"The Man of Room 40: The Life of Sir Alfred Ewing 1939. (Hutchinson.) 12*s.* 6*d.*

BRITISH GUIANA. HODGE, L. P. "Natural Tidal Drainage, more particularly British Guiana." 1939. (Georgetown Daily Chronicle.) 40 cents.

BUILDING. GUNN, E. "Modern Building Technique. Domestic and Simil Structures." 1939. *Architect & Bldg. News.* 6*s.*

—— WAR OFFICE. "Schedule of Prices for Works and Repairs to Buildings 1939. (H.M.S.O.) 10*s.*

—— *See also* LONDON; MATERIALS.

CONCRETE. TROXELL, G. E., and H. E. DAVIS. "Making and Testing of Pla Concrete." 1938. (Stanford Univ. Press, Berkeley, Cal.) 8*s.* 9*d.*

DAMS. ESCANDE, L. "Barrages." 3 Parts. 1937. (Hermann, Paris.) 15*s.*

—— HOFACKER, K. "Talsperrengewölbe." 1936. (Leemann, Zurich.) 8*s.* 6*d.*

EARTHWORK. *See* RETAINING WALLS.

ELECTRICITY-SUPPLY. "Electricity Commissioners' Report on the Breakdown Blackpool." 1939. (H.M.S.O.) 1*s.* 6*d.*

—— "Electricity Commissioners' Report on a Failure of Supply at Kingston-upo Thames." 1939. (H.M.S.O.) 2*s.* 6*d.*

ELECTROCHEMISTRY. GLOCKLER, C., and S. C. LIND. "Electrochemistry of Gas and other Dielectrics." 1939. (Chapman & Hall.) 30*s.*

EXHAUST SYSTEMS. ALDEN, J. L. "Design of Industrial Exhaust Systems." 193 (Mach. Pub'g Coy.) 15*s.*

ORESTRY. *See* SWEDEN.

OUNDATIONS. *See* SOILS.

AS MAINS. RESTALL, R. J. "Notes on High Pressure Gas Main Construction." 1939. (W. King.) 10*s*. 6*d*.

AS PRODUCERS. CRAWFORD, D. R. G. "The Gas Producer Operator's Handbook." 1939. (Crosby Lockwood.) 4*s*. 6*d*.

OUSING. MINISTRY OF HEALTH. "Houses we Live in." 1939. (H.M.S.O.) 1*s*.

YDRAULICS. KHANNA, R. K. "Fundamentals of River and Canal Hydraulics." 1939. (Rama Krishna & Sons, Lahore.) 2 Rupees.

YGIENE. CHENOWETH, L. B., and W. MACHLE. "Industrial Hygiene." 1938. (Pitman.) 10*s*. 6*d*.

NDIA. BAYLEY, V. *"Indian Artifex." 1939. (Robert Hale.) 12*s*. 6*d*.

— WADIA, D. N. "Geology of India." 2nd ed. 1939. (Macmillan.) 24*s*.

IBRARIES. HAMLIN, T. "Some European Architectural Libraries." 1939. (Columbia University Press.) 15*s*.

ONDON. DICKSEE, B. (*Ed.*). "London Building Acts. 1930 and 1935 Supplement." 1938. (Stanford.) 12*s*. 6*d*.

ATERIALS. KNIGHT, B., and R. G. "Builders' Materials." 1939. Arnold. 15*s*.

ECHANICS. DEN HARTOG, J. P., and H. Peters., *Eds*. "Proceedings, 5th International Congress for Applied Mechanics." 1939. (Chapman and Hall.) 36*s*.

This volume of 750 pages, covering the proceedings of the Congress held at Cambridge, Mass., in Sept. 1938, contains three general lectures on the mechanics of solids, forty-four Papers on the elasticity and properties of materials, three lectures and sixty-three Papers on fluid mechanics, and seventeen Papers on dynamics.

OWER. WORLD POWER CONFERENCE. *"Transactions, Vienna Sectional Meeting, 1938." 1939. 7 Vols. (Lund, Humphries.) £9 17*s*. 6*d*.

AILWAYS. GREENLEAF, H., and H. HAYDEN. "Britain's Railways." 1938. (Muller.) 6*s*.

EFRACTORIES. SEARLE, A. B. "Refractories for Furnaces, Kilns, Retorts, etc." 1939. (Crosby Lockwood.) 3*s*. 6*d*.

The characteristics of the principal raw and manufactured refractory materials are discussed, and the processes and machinery employed in their production are described. A useful bibliography of the literature on refractories is included.

ETAINING WALLS. THAYER, H. R., and Others. "Earthwork and Retaining Walls." 1937. (International Textbook Co.) 10*s*.

OADS AND STREETS. GUBBELS, J. L. "American Highways and Roadsides." 1938. (Houghton Mifflin, Boston.) 14*s*.

CHOOLS. SEYMOUR, W. D. "Heating, Ventilation, and Lighting of School Buildings." 1939. (Oxford Univ. Press.) 12*s*. 6*d*.

EWAGE-DISPOSAL AND SEWERAGE. RŬCHHOFT, C. C., and Others. "Biochemical Oxidation by Activated Sludge." 1938. (Supt. of Documents, Washington.) 10 cents.

ILICOSIS. LANZA, A. J. *Ed*. "Silicosis and Asbestosis." 1938. (Oxford Medical Publications.) 25*s*.

SOILS. U.S. CORPS OF ENGINEERS, U.S. ARMY ENGINEERING DEPARTMENT. *" Pr[oceedings], Soils and Foundation Conference, 1938." 1939. (Boston, Corps [of] Engineers, U.S. Army.) No price.

The investigations and studies of cohesionless soils conducted by the Bost[on] Engineer District are reviewed, and the results of investigations of soil problem[s] at Harvard University and the Massachusetts Institute of Technology are pr[e]sented. A description is given of a machine developed at the Institute for dete[r]mining the shearing strength of soils.

STRENGTH OF MATERIALS. CORMACK, J. A., and E. R. ANDREW. " Properties an[d] Strength of Materials." 1939. (Macmillan.) 8s. 6d.

STRUCTURES. MOON, A. R. " Design of Welded Steel Structures." 1939. (Pi[t]man.) 15s.

SUBMARINES. EDWARDS, K. *" We Dive at Dawn." 1939. (Rich & Cowan[.)] 12s. 6d.

SUBWAYS. CONKLIN, G. " All about Subways." 1938. (Messner, New York.) 15[s.]

SURVEYING. WILLIS, A. J. " More Advanced Surveying." (Crosby Lockwood[.)] 21s.

The distinctive features of this advanced text-book include examples of takin[g] off of general building work, with a " running commentary " on pages facin[g] every example. Full references are given to the Standard Method of Measure[]ment. A chapter is devoted to writing the specification from the bill of quantitie[s] including a method of combining the bill and the specification.

SWEDEN. STREYFFERT, TH. " The Forests of Sweden." 1938. (Stockholm[.)] 1 dollar.

(* *The foregoing books, with the exception of those marked with an asterisk, may b[e] borrowed from the Library.*)

LOCAL ASSOCIATIONS.

CHAIRMEN AND HONORARY SECRETARIES.

The names of Chairmen and the names and addresses of the Honorary cretaries of Local Associations are :—

IN THE BRITISH ISLES.

RMINGHAM. *Chairman.*—E. E. JEAVONS, M. Inst. C.E. *Hon. Secs.*—S. J. Davies, Assoc. M. Inst. C.E., Public Works Department, Dell Road, Cotteridge, Birmingham, and H. L. Price, Stud. Inst. C.E., 63 Middleton Hall Road, Kings Norton, Birmingham.

ISTOL. *Chairman.*—A. M. PATERSON, M.C., M. Inst. C.E. *Hon. Sec.*—T. B. Cooper, B.Sc., Assoc. M. Inst. C.E., Refuge Assurance Buildings, Bristol 1.

INBURGH. *Chairman.*—P. B. GLENDINNING, M. Inst. C.E. *Hon. Secs.*—J. A. McGregor, B.Sc., Assoc. M. Inst. C.E., 10 Craiglea Drive, Edinburgh 10, and D. A. Coode, Stud. Inst. C.E., Orwell Lodge, Juniper Green, Midlothian.

ASGOW. *Chairman.*—Professor GILBERT COOK, D.Sc., M. Inst. C.E. *Hon. Secs.*—William MacGregor, B.Sc., Assoc. M. Inst. C.E., Engineering Department, The University, Glasgow, W.2, and W. M. Cormie, B.Sc., Stud. Inst. C.E., Glenfield, Dumbuck Crescent, Dumbarton.

WCASTLE-UPON-TYNE. *Chairman.*—P. A. R. LEITH, M. Inst. C.E. *Hon. Secs.*—W. M. Anderson, Assoc. M. Inst. C.E., c/o J. M. Rounthwaite, B.Sc., 3 Ellison Place, Newcastle-upon-Tyne 1, F. N. B. Patterson, B.Sc., Stud. Inst. C.E., Northumberland County Engineer's Office, County Hall, Newcastle-upon-Tyne 1, with Thomas Storer, Stud. Inst. C.E., Borough Engineer's Office, Victoria Buildings, Stockton-on-Tees. (Tees-side Branch.)

RTH-WESTERN. *Chairman.*—R. D. BROWN, M. Inst. C.E. *Hon. Secs.*—R. J. Cornish, M.Sc., Assoc. M. Inst. C.E., Municipal Engineering Department, College of Technology, Manchester 1, and J. Dann, M.Sc. Tech., Stud. Inst. C.E., Mill Farm, Green Lane, Baguley, Manchester.

RTHERN IRELAND. *Chairman.*—ROBERT MCCREARY, M.C., B.Sc., M. Inst. C.E. *Hon. Secs.*—S. H. W. Middleton, B.A., B.A.I., Assoc. M. Inst. C.E., Water Office, Belfast, and D. F. Wilkin, B.Sc., Stud. Inst. C.E., Engineer's Office, Bye-Pass Road, Sydenham Road, Belfast.

UTH WALES AND MONMOUTHSHIRE. *Chairman.*—JAMES HASSALL, M. Inst. C.E., *Hon. Secs.*—G. W. Cover, Assoc. M. Inst. C.E., Water Engineer, City Hall, Cardiff, and J. W. Cotterill, Stud. Inst. C.E., Hillsboro', Llandough, nr. Cardiff.

UTHERN. *Chairman.*—JOSEPH HAWKSLEY, B.Sc., M. Inst. C.E. *Hon. Secs.*—P. E. Sleight, M. Eng., Assoc. M. Inst. C.E., The Municipal College, Portsmouth, and R. W. Querée, Stud. Inst. C.E., City Engineer's Department, Guildhall, Portsmouth.

RKSHIRE. *Chairman.*—J. TAYLOR THOMPSON, M.C., M. Inst. C.E. *Hon. Secs.*—J. H. W. Freeman, B.Sc., Assoc. M. Inst. C.E., Briarcliffe, Harrogate Road, Alwoodley, Leeds, and David Garside, B.Sc., Stud. Inst. C.E., Borough Engineer's Department, Rotherham.

OVERSEAS.

BUENOS AIRES. *Chairman.*—J. F. MAIN, M. Inst. C.E. *Hon. Secs.*—H. W. Steve B.Sc., Assoc. M. Inst. C.E., Guanahani 322, Buenos Aires, and E. N. R. Bu Stud. Inst. C.E.

MALAYAN. *Chairman.*—J. R. CASELEY, B.Sc., M. Inst. C.E. *Hon. Sec.*—J. Chester, Assoc. M. Inst C.E., P.W.D., Singapore, S.S.

SHANGHAI. *Chairman.*—A. F. GIMSON, M.C., B.Sc., M. Inst. C.E. *Hon. Sec.*—R. Whittington, M.Sc., Assoc. M. Inst. C.E., The Henry Lester Institute, East Seward Road, Shanghai.

VICTORIAN. *Chairman.*—L. R. EAST, M.C.E., M. Inst. C.E. *Hon. Sec.*—W. D. Cha man, M.C.E., Assoc. M. Inst. C.E., 53–55 Collins Place, Melbourne, Victo Australia.

WEST INDIES. *Chairman.*—S. R. H. BEARD, M. Inst. C.E. *Hon. Sec.*—M. F. Ward, Assoc. M. Inst. C.E., 1c Wrightson Road, P.O. Box 269, Port-of-Spa Trinidad, B.W. Indies.

It is regretted that conditions arising out of the war have prevent the Local Associations from proceeding with their usual programmes meetings. The Birmingham and District, Edinburgh and Distri and Yorkshire Associations propose to hold restricted programmes meetings during the course of the Session, particulars of which will issued to Members and Students in the districts concerned by the loc Honorary Secretaries. The Bristol and District, Glasgow and Distri Newcastle-upon-Tyne and District, North-Western, South Wales an Monmouthshire, and Southern Associations have decided to suspen meetings for the present.

ASSOCIATION OF LONDON STUDENTS.

An invitation is given to Students who are members of the Associati to contribute technical notes (of, say, 1,000–1,500 words) which they co sider may be of interest to fellow Students. Such notes will be consider with a view to publication in the Journal.
